EXHIBIT C

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EXPERT REPORT OF DR. PAUL R. KRAUSE REGARDING THE ECOLOGICAL IMPACTS OF LEAD ORIGINATING FROM SUBMERGED TELECOMMUNICATION CABLES IN LAKE TAHOE.

CASE NUMBER 2:21-CV-00073-JDP

RAMBOLL

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ACRONYMS AND ABBREVIATIONS

AWQC	Ambient water quality criteria
BERA	Baseline Ecological Risk Assessment
CAFE	Chemical Aquatic Fate and Effects
CCR	Consumer Confidence Reports
CEDEN	California Environmental Data Exchange Network
CPUC	California Public Utilities Commission
CSM	Conceptual Site Models
EPA	Environmental Protection Agency
ERA	Ecological risk assessment
MDL	Method detection limit
ND	Not detected
NDEP	Nevada Division of Environmental Protection
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
OEHHA	Office of Environmental Health Hazard Assessment
PNEC	Predicted no-effect concentration
RCRA	Resource Conservation and Recovery Act
SQuiRT	Screening Quick Reference Tables
SSD	Species sensitivity distribution
SWAMP	Surface Water Ambient Monitoring Program
TSAC	Tahoe Science Advisory Council
UC	University of California
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

QUALIFICATIONS OF DR. KRAUSE

I am a Principal with Ramboll, located in Los Angeles, CA. I have over 30 years of experience in the fields of aquatic and marine ecology, ecological toxicology, environmental impact analysis, ecological risk assessment, modeling, and regulatory permitting and negotiation. I earned my Ph.D. in environmental toxicology from the University of California at Santa Barbara in 1993. I was the recipient of a University of California research fellowship and a National Academy of Science postdoctoral fellowship. Currently, I manage Ramboll's Impact Assessment and Ecological Risk team in Southern California. My area of expertise is in developing impact assessments and ecological risk assessments in aquatic and marine environments for a variety of clients. Throughout my professional career, I have managed a large environmental biological testing laboratory, supported numerous ecological risk assessments, prepared discharge studies, developed and managed toxicological evaluations of waters and sediments, and led permit negotiations. I am an internationally recognized expert on ecotoxicological effects on aquatic biota and sediments from environmental contaminants.

For this project my rate at Ramboll is $490 per hour. I have not acted as a retained expert or testified in trial or by deposition in any other cases in the previous four years. My Curriculum Vitae is included as Appendix A hereto.

MATERIALS REVIEWED AND RELIED UPON

In the development of my opinions, I relied on various sources of information along with my background as an ecotoxicologist. In addition to the literature cited in this report, the other sources of information that I reviewed and relied upon to formulate my opinion include the following:

- AT&T Permit Drawings A020LET
- National Oceanic and Atmospheric Administration Chemical Aquatic Fate and Effects Database (https://response.restoration.noaa.gov/cafe)
- Plaintiff's Complaint (Case No. 2:21-CV-00073-JDP, Document 1, Filing 01/14/21)
- Plaintiff Supplemental Declaration of M. Maclear (Case No. 2:21-CV-00073-JDP, Document 123, Filing 02/01/24)
- Environmental sampling data
- Site videos and photographs obtained by Below the Blue/Marine Taxonomic Service
- Ramboll site photographs and videos collected during 2023 sampling events.

EXECUTIVE SUMMARY

I am an expert in aquatic ecology, toxicology, and environmental impact analysis with over 30 years of experience. For this report, I conducted an ecological risk assessment (ERA) to understand the potential ecological risks from lead-clad telecommunications cables in Lake Tahoe.

Lake Tahoe's water quality has been extensively studied, mainly because it serves as a source of drinking water. Lead levels reported by 13 water utilities average 3 micrograms per liter, which is well below safe drinking water limits and likely associated with lead in plumbing and/or erosion of natural deposits, according to Consumer Confidence Reports. Further data from various programs and the literature indicate minimal lead at most sampling stations, with industrial and groundwater sources being significant contributors to lead presence in the lake.

Lake Tahoe is known for being a subalpine deepwater oligotrophic (i.e., low-nutrient) lake with remarkable water clarity (Noble et al. 2023). As with many lakes of this type, Lake Tahoe lacks the biodiversity typical of mesotrophic and eutrophic freshwater lakes in lower altitudes and warmer ecoregions. A detailed examination of the lake's aquatic receptors was conducted to determine potential lead impacts, which included biofilms, algae, benthic invertebrates, and fishes.

The methodological approach I used to determine impacts followed a standardized United States Environmental Protection Agency (USEPA) tiered ERA framework, allowing for progressively sophisticated evaluations (USEPA 1998). Under this approach, which relied upon site-specific data for lead concentrations in water and sediment collected by Ramboll (2023), ecological risk is evaluated through a two-step process. The first step is a Screening Level Ecological Risk Assessment (SLERA) where site-specific lead concentrations are compared to published and scientifically accepted toxicity threshold levels. If lead concentrations are found to be below these thresholds a finding of no risk is warranted. If lead concentrations are above these thresholds and risk is found, a second Baseline Ecological Risk Assessment step would be completed. If no risk is found at the SLERA stage, then the ERA is concluded.

For this ERA, data from laboratory tests for water and sediment samples collected in the Lake near the cables were compared against multiple toxicity benchmarks to determine ecological risk in a SLERA step. Additionally, data were compared to published background concentrations expected for lead, and a general comparison was made against reference and beach locations.

The results of the SLERA were clear that all lead concentrations were below established toxicity thresholds, indicating no ecological risk.

Utilizing results from various the data collections, observations and the ERA, my opinions are as follows:

Opinion 1: There is no ecological risk to aquatic receptors in Lake Tahoe from lead-clad telecommunication cables.

> **Opinion 1A:** There is no ecological risk to aquatic receptors in Lake Tahoe from lead found in waters near the telecommunications cables.
>
> **Opinion 1B:** There is no ecological risk to aquatic receptors in Lake Tahoe from lead found in sediments near the telecommunications cables.

Opinion 2: Telecommunications cables are not contributing to elevated lead concentrations in Lake Tahoe waters or sediments.

Opinion 3: Observations also show no impact of lead from the telecommunication cables on aquatic resources or the ecology of Lake Tahoe.

Opinion 4: Based on multiple lines of evidence, there is no impact of lead from the telecommunication cables on aquatic resources of Lake Tahoe.

In conclusion, it is my opinion that there is no ecological risk to aquatic receptors in Lake Tahoe from lead-clad telecommunication cables and they are not contributing to elevated lead concentration in Lake Tahoe's water or sediments.

1. BACKGROUND

The purpose of this document is to provide my opinions on potential lead exposure to ecological receptors from telecommunication cables in Lake Tahoe, California. At issue are two submarine cables that are currently located on the floor of the lake. The cables extend from shore and run offshore at various depths. Currently the cables lie on and in sand beds, run over cobble and boulder fields, and are often suspended between deep ledges. The location and configuration are typical of submarine cables in aquatic environments.

One cable runs from west to east across the mouth of Emerald Bay located in the southwestern portion of Lake Tahoe. This cable is approximately 1,000 feet (ft) in length and has been designated as "Cable A". The second cable runs approximately 6 miles in length from the Baldwin Beach area on the southwest shore of Lake Tahoe and runs north to the Lonely Gulch area of Rubicon Bay on the western shoreline. This has been designated as "Cable B". The cables are approximately 33,000 ft in length combined. This report is primarily based on my direct knowledge of Cables A and B.

To protect the interior conductors, the telecommunication cables were designed to be placed in an aquatic environment. The cable contains an inner conducting copper core surrounded by a lead sheath. Surrounding the inner core and lead sheath are a waterproof membrane, followed by a layer of wrapped steel rods for protection. Finally, there is an outer waterproof covering of jute impregnated bitumen.

Lake Tahoe is a remote subalpine lake, with an elevation of 1897 meters. The watershed surrounding Lake Tahoe boasts unique features (i.e., nutrient-poor soils, erosion-resistant substrate, dense forest cover) which ultimately minimize terrestrial runoff (Chien et al. 2019). Despite its large size, Lake Tahoe remains oligotrophic, resulting in remarkably high-water clarity. This clarity has significantly declined since the 1960s, as documented by the Tahoe Environmental Research Center (TERC, 2016; Chien et al. 2019). The reasons behind this decline are multifaceted, with increasing population, land use changes, and anthropogenic emissions playing crucial roles (Huang et al., 2013; Jassby et al., 1994; Juma et al., 2014; Chien et al. 2019). In addition, waters of Lake Tahoe are known to have a low level of hardness, measured as calcium chloride, compared to other water sources. This low level of hardness can affect the toxicity of some contaminants such as lead (USEPA 1985).

1.1 Relevant Regulatory Framework

The basis of this case revolves around three laws – two California and one federal – invoked in Plaintiff's lawsuit. These form the framework for the opinions provided in this report.

1.1.1 California Fish and Game Code

California Fish and Game code Section 5650 states that "it is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of this state any of the following *(1) Any petroleum, acid, coal or oil tar, lampblack, aniline, asphalt, bitumen, or residuary product of petroleum, or carbonaceous material or substance. (2) Any refuse, liquid or solid, from any refinery, gas house, tannery, distillery, chemical works, mill, or factory of any kind. (3) Any sawdust, shavings, slabs, or edgings. (4) Any factory refuse, lime, or slag. (5) Any cocculus indicus. (6) Any substance or material deleterious to fish, plant life, mammals, or bird life"*.

The Plaintiff is claiming the lead inner core of the telecommunication cables is leaching (i.e., dissolving) into the aquatic environment of Lake Tahoe, potentially causing harm to aquatic creatures such as fish and plant life.

1.1.2 California Proposition 65

Another applicable law pertaining to this Expert Report is Proposition 65, the Safe Drinking Water and Toxic Enforcement Act of 1986. Proposition 65 requires consumer warnings for the sale of products containing chemicals known to the state of California to cause cancer or reproductive harm. It also prohibits the discharge of such chemicals to sources of drinking water in excess of regulatory limits (Health & Safety Code Section 25249.5).

Lead and lead compounds are listed under the Office of Environmental Health Hazard Assessment (OEHHA) Proposition 65 list (last updated December 29, 2023) (OEHHA 2023). However, there is an exemption to the "discharge prohibition." It does not apply to any discharge or release that does not cause a significant amount of the chemical to enter a source of drinking water and is in conformity with all other laws and applicable regulations.

Within the context of this case, Plaintiffs allege that the cables represent a continuous release of lead to Lake Tahoe that is leading to significant ecotoxicological impacts to aquatic biota in Lake Tahoe.

1.1.3 Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA), enacted in 1976, is a federal law that governs the management and disposal of hazardous and non-hazardous waste. Enforced by the United States Environmental Protection Agency (USEPA), RCRA aims to protect public health and the environment, by ensuring proper transport and disposal of hazardous waste.

RCRA 42 U.S.C. § 6972(a)(1)(B) specifically states that "*any person may commence a civil action on his own behalf against any person, including the United States and any other governmental instrumentality or agency, to the extent permitted by the eleventh amendment to the Constitution, and including any past or present generator, past or present transporter, or past or present owner or operator of a treatment, storage, or disposal facility, who has contributed or who is contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste which may present an imminent and substantial endangerment to health or the environment.*"

Within the context of this case, the Plaintiff have alleged that the presence of the telecommunication cable in Lake Tahoe represents an imminent and substantial endangerment to the environment through continuous discharge of lead.

1.2 Summary of Opinions

This report provides opinions on several aspects of ecotoxicological exposure and risk associated with telecommunications cables located in Lake Tahoe. I focus on ecological risks from potential lead exposure to representative aquatic species. My opinions are as follows:

Opinion 1: There is no ecological risk to aquatic receptors in Lake Tahoe from lead-clad telecommunication cables.

> **Opinion 1A:** There is no ecological risk to aquatic receptors in Lake Tahoe from lead found in waters near the telecommunications cables.

Opinion 1B: There is no ecological risk to aquatic receptors in Lake Tahoe from lead found in sediments near the telecommunications cables.

Opinion 2: Telecommunications cables are not contributing to elevated lead concentrations in Lake Tahoe waters or sediments.

Opinion 3: Observations also show no impact of lead from the telecommunication cables on aquatic resources or the ecology of Lake Tahoe.

Opinion 4: Based on multiple lines of evidence, there is no impact of lead from the telecommunication cables on aquatic resources of Lake Tahoe.

1.3 History of Lead Levels in Lake Tahoe

Water quality has been studied extensively in Lake Tahoe by the Tahoe Science Advisory Council, United States Geological Survey (USGS), and by universities such as University of California (UC) Davis (Heyvaert et al. 2022, Naranjo et al. 2022, UC Davis 2022). The most common variables measured are air temperature, water clarity, precipitation and snowpack, lake surface level, water temperature, mixing and stratification, nutrient levels (phosphorous, nitrogen, and suspended sediment), and biology (such as algal growth, productivity, diatom, zooplankton).

Since Lake Tahoe serves as a drinking water source for municipalities within both Nevada and California, including Incline Village, North Tahoe, Tahoe City, Glenbrook, Logan Creek, Cave Rock/Skyland, Uppaway, Zephyr Cove, Elk Point, Kingsbury, Edgewood, and South Tahoe, 13 water utilities publish Consumer Confidence Reports (CCRs) (Tahoe Regional Planning Agency 2016). The 13 utilities include (California Public Utilities Commission 2024, Nevada Division of Environmental Protection [NDEP] 2020):

1. Incline Village (Incline Village Public Works 2022)
2. North Tahoe (North Tahoe Public Utility District 2021)
3. Tahoe Main (Tahoe City Public Utility District 2020a)
4. McKinney/Quail (Tahoe City Public Utility District 2020b)
5. Rubicon (Tahoe City Public Utility District 2020a)
6. Cedars (Tahoe City Public Utility District 2020b)
7. Alpine Peaks (Tahoe City Public Utility District 2020a)
8. Madden Creek (Tahoe City Public Utility District 2020c)
9. Timberland (Tahoe City Public Utility District 2020d)
10. Round Hill (Round Hill General Improvement District 2022)
11. South Tahoe (South Tahoe Public Utility District 2022)
12. Kingsbury (Kingsbury General Improvement District 2023)
13. Zephyr Cove (Zephyr Cove Water Utility District 2023)

Although raw water quality tests are not included in CCRs, treated water quality is measured within samples collected from the tap water within homes. Recognizing these samples have the potential to be influenced by contact by water treatment chemicals and exposure to materials within the distribution and domestic plumbing systems, results may not be fully reflective of source concentrations. CCRs provide the 90th percentile results of common water quality parameters including lead. Of the 13 utilities providing CCRs for water sourced from Lake Tahoe, the average concentration for those with detections of lead is 3 micrograms per liter (µg/L) or parts per billion. Each of the CCRs listed above determine that the lead detected in the samples is likely from plumbing and/or erosion of natural deposits. For example, the report from the South Tahoe Public Utility District (2022) indicated that the most likely sources of lead to Lake Tahoe are the result of a combination of runoff (e.g., agriculture, stormwater, snowmelt), atmospheric deposition, and groundwater.

In addition to house tap water samples, historical sediment and water quality data is available from Nevada Water Quality, California's Surface Water Ambient Monitoring Program (SWAMP) and California Environmental Data Exchange Network (CEDEN). The database search found 44 tests involving the name "Tahoe". While the station locations were difficult to determine, results showed that one station (Cave Rock, 2001) detected lead at 3 µg/L. The rest of the stations showed no detectable results for lead. California SWAMP tested for metals in sediment in Upper Truckee River near the inlet to the lake at eight different instances between 2008 and 2020. Lead was detected during all eight sampling events at an average of 13.1 milligrams per kilogram (mg/Kg) or parts per million. Additionally, between 2008 and 2012, California SWAMP sampled fine fraction sediment in the Upper Truckee River near the inlet to the lake in four separate instances. All samples came back with lead concentrations with an average of 17.8 mg/Kg. Finally, California CEDEN tested two samples in Dollar Hill Sand Vault Located near Tahoe City and via Tahoe City Effluent in 2018. Both samples tested positive for lead at 3 and 0.94 µg/L.

1.3.1 Sources of Lead in Lake Tahoe

Little research has been conducted on metals in the waters and sediments of Lake Tahoe, however, there exists a body of work looking at sources of lead to water and sediments, and relative concentrations in selected locations in and around the lake. Figure 1 shows a diagram published by the NDEP describing various pollutants (including lead) for Lake Tahoe. This effectively serves as a model to understand the various and complex inputs of lead to the ecosystem including waters and sediments.

In addition to the various inputs shown in Figure 1, it has been shown that lead weights associated with recreational fishing are commonly lost in the lake accidentally and contribute a significant source of lead to the lake ecology. For example, the Restoring the Lake Depths Foundation, a non-profit in South Lake Tahoe, utilized a deepwater robot to pull refuse from Lake Tahoe in the summer of 2023 (Dundas 2023). During that summer, the robot pulled nearly 5 tons of materials from Lake Tahoe, 1 ton of which included alcohol bottles containing lead and cadmium (Restoring the Lake Depths Foundation 2023). Additionally, cameras, drones, lithium batteries, and a 16,000-pound electric boat were discovered.

Figure 1: Potential Input Pathways for Contaminants in Lake Tahoe

Source: https://ndep.nv.gov/uploads/documents/Lake_Tahoe_Nearshore_Pollutants__Sources__Effects.pdf.

1.3.2 Water Lead Concentrations

Lead concentrations in Lake Tahoe have been recorded by researchers; however, the focus was collecting samples from various depths throughout the water column and contributing systems (i.e., tributaries not part of the lake).

Chien et al. (2019) evaluated trace metal concentrations and lead isotope ratios in lake water, river water, ground water, and aerosol total suspended particles from 2013 to 2016. Water depth profile samples were collected from the lake seven times over various seasons. Samples were collected at depths of 50, 100, 150, 200, 250, 300, 400, 450 meters (m), and at the surface level at the Mid-Lake Tahoe profile station. Groundwater samples were sourced from two wells at the Lake Tahoe fire station and three wells at the Hatchery. Additionally, river water samples were collected from Third Creek, Trout Creek, Upper Truckee River, Ward Creek, Incline Creek, Blackwood Creek, and General Creek. Samples underwent filtration using acid-washed 0.45 micrometer (µm) filters. For trace metal and Pb isotope analyses, the samples were further acidified to a pH below 2 using concentrated double-distilled nitric acid. Laboratory water blanks were also analyzed. The water samples were collected for trace metals and Pb isotope analyses, following the methodology outlined by Chien et al. (2017).

Results showed that trace metal concentrations varied seasonally but did not vary vertically within the lake water column. Additionally, it was shown that the major sources of lead were from riverine and groundwater inputs. Aerosols did contribute to the lake, but in smaller quantities. The data from Chien et al. (2019) is summarized below.

- Groundwater (collected 2013) 5 samples avg 0.71 µg/L (0.13 – 2.44 µg/L);
- River (collected 2016) 7 samples avg 0.028 µg/L (0.002 – 0.137 µg/L); and
- Lake (collected 2013-2016) 59 samples avg 0.017 µg/L (0.003 – 0.058 µg/L).

1.3.3 Sediment Lead Concentrations

Modern industrial processes have contributed to the dispersion of metals in the environment, particularly through atmospheric emissions (Heyvaert et al. 2000). The introduction of alkyl-leaded gasoline in 1923 produced airborne lead that was widely dispersed and deposited around the world, including in remote areas (e.g., the Arctic; Heyvaert et al. 2000). While anthropogenic emission rates have decreased dramatically since leaded gasoline was phased out, few studies have recorded the preindustrial and postindustrial conditions to evaluate lead concentrations over time, especially in remote locations. To better understand this, Heyvaert et al. (2000) examined lead accumulation rates and mercury deposition in Lake Tahoe from sediment cores.

Sediment cores were collected with a Soutar box corer, which recovers an area of approximately 60 centimeters (cm) deep by 30 cm^2. Two box cores were extracted from opposite ends of the lake in the profundal zone below 400 m, and a third was taken off the west shoreline at approximately 300 m depth. The box core samples were immediately subcored and sectioned at regular intervals using a vertical hydraulic extruder. Concentrations of lead (specifically ^{210}Pb) were determined by measuring the activity of its decay product.

Results showed that baseline concentration ranged from 11 to 13 mg/Kg for lead, while surficial concentrations ranged from 77 to 86 mg/Kg. Baseline conditions were calculated as an average of the three deepest sediment sections, while surficial were calculated based on the average of the shallowest sections. Heyvaert et al. (2000) states that it appeared lead was immobilized, and that patterns in concentrations were varied over time.

Additionally, Heyvaert et al. (2000) calculated the automotive Pb emissions at Lake Tahoe for 1976, using fuel consumption records. Leaded gasoline was phased out and replaced with unleaded starting in 1975, and by 1976 unleaded gasoline accounted for 18% of the total market. Using this data, paired with aerial deposition models, the calculations suggest that the lead emitted throughout the basin during this time (e.g., 1923 to 1976), accounts for more of the lead burden measured in the more recently deposited sediments in the lake (i.e., sediment near the top of the core).

1.4 Aquatic Receptors in Lake Tahoe

Lake Tahoe is known for being a subalpine deepwater oligotrophic (low-nutrient) lake with remarkable water clarity (Noble et al. 2023). As with many lakes of this type, Lake Tahoe lacks the biodiversity typical of mesotrophic and eutrophic freshwater lakes in lower altitudes and warmer ecoregions. Biodiversity of the lake has increased post American settlement with both the deliberate and accidental introduction of various species. Figure 2 shows a stylized food web for Lake Tahoe (Chandra et al., 2010). Phytoplankton, benthic algae, and associated biofilms form the base of the food web along with some vascular plants. Vascular plants exist in embayments and still water locations in certain parts of the lake. Zooplankton include Dioptums and Epischra copepods, daphnia, and bosmina along with the introduced mysid shrimp, *Mysis diluviana*. The zooplankton feed primarily on the phytoplankton in the

lake. Both phytoplankton and zooplankton exist in the water mass of the lake and their movements are subject to lake currents and associated water masses. On the lake bottom (i.e., benthos), nearshore benthic macroinvertebrates include the native blind amphipod, chironomids, pea clam, and Tahoe stonefly along with the introduced Asian clam and signal crayfish. These organisms forage along the bottom feeding primarily on detritus and filtering plankton from the water. Crayfish are opportunistic feeders and will feed on both detritus and organisms they can catch including bivalves. Fishes of the lake can be divided into offshore (pelagic) fishes, mainly consisting of native and introduced Salmonids, and nearshore (littoral)/benthic fishes of various introduced and native species. Nearshore/benthic species feed on zooplankton and benthic invertebrates, while the offshore species feed primarily on smaller fishes, zooplankton and sometimes benthic invertebrates.

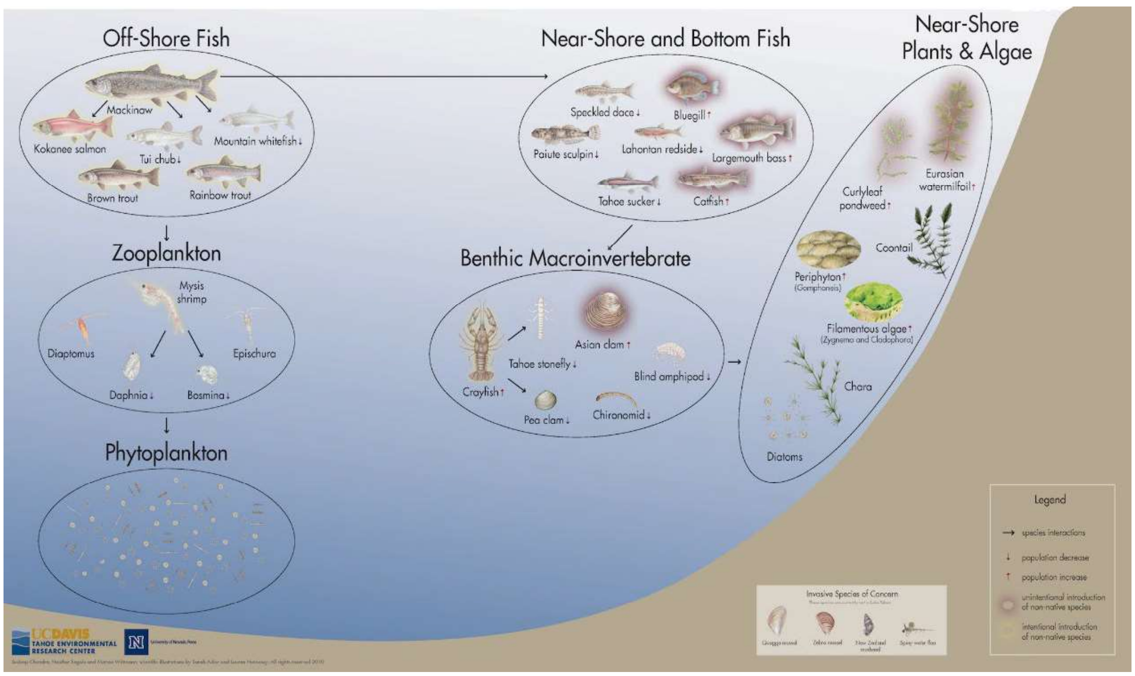


Figure 2: Lake Tahoe Food Web Diagram

Source: Chandra et al., 2010.

1.4.1 Biofilms and Algae

Exposed surfaces in Lake Tahoe such as rocks (boulders and cobble), sand, and large organic debris (e.g., sunken trees and wood) form a source of organic matter to the aquatic food chain. These surfaces, especially those exposed to sunlight in the littoral zone (e.g., depths up to 100 ft) are covered with biofilms made up of bacterial mats, algae as well as algal and plant detritus from the overlying water column. These biofilms provide the basis of the food chain.

Periphytic algae, slimy green algae that clings to rocks, and metaphylic algae, free floating algae, are Lake Tahoe's main primary producers, though significant epipsammic algae exists clinging on and between sand grains. Since the mid-2000's nuisance nearshore algal growth has been attributed to human induced stressors and eutrophication which has altered the species makeup of the system (Noble et al. 2023).

1.4.2 Benthic Invertebrates

Benthic invertebrate diversity of Lake Tahoe is characteristically low. There are five dominant species found in the lake. Regulatory agencies are active in working to eradicate the invasive aquatic species including fish, invertebrates, and plants through various methods. The lake has two dominant bivalve species (clams), one native and one introduced. Additionally, the most prominent mobile invertebrate species is the crayfish. Other lesser invertebrates are found in the lake and primarily consist of infaunal (i.e., organisms living in the sediment) areas of the mud and sand substrate of the lake.

1.4.2.1 Bivalves

The Asian clam (*Corbicula fluminea*) is an invasive species in freshwater ecosystems which experience early maturity, high fecundity, and rapid growth within their short life span (Sousa et al. 2008). Asian clams tolerate low water temperatures and prefer sandy sediments mixed with silt and clay; however, they can be found in many ecosystems with or without submerged vegetation. The Asian clam matures within 3 to 6 months and the shell length of an adult is typically between 6 to 10 millimeters (Sousa et al. 2008). The average life span of Asian clams is highly variable, lasting between 1 and 5 years, although typically they have low survivorship in both juveniles and adults (Sousa et al. 2008, Rhode Island Department of Environmental Management 2017). With high reproductive rates, the majority of the population is made up of juvenile individuals (Sousa et al. 2008). This species reproduces twice a year typically in the spring going through the summer and starting in late summer and going through fall.

The Asian clam is known as a bioindicator species due to its presence in many freshwater habitats (Sousa et al. 2008). Its high filtration capacity and ability to capture large quantities of water borne contaminants such as metals, makes it a good bioindicator for heavy metals. The Asian clam inhabits benthic environments, consuming large amounts of primary producers, by filtering water at high rates (Sousa et al. 2008).

1.4.2.2 Crustaceans

As Lake Tahoe has low relative biodiversity compared to other lakes, signal crayfish (*Pacifastacus leniusculus Dana*) were introduced into Lake Tahoe by resource managers to provide additional food resources for game fish (Tahoe Environmental Research Center 2024). Signal crayfish live mostly nocturnal lives and can grow up to around 7 inches long. They are benthic omnivores that prefer colder water temperatures and commonly hide under rocks, root systems, and tree logs (Tahoe Environmental Research Center 2024).

Due to seasonal temperature variation in Lake Tahoe, crayfish occupy nearshore, shallow waters during the summer and early autumn, while in late autumn they move to deeper waters, resulting in peak activity in warmer seasons and low activity during winter months (Flint 1977). Further, based on research regarding the diet of Lake Tahoe trout conducted by Frantz and Cordone (1970), evidence of crayfish in the stomachs of trout were lowest in the

winter (7.2%), moderate in the spring and autumn (9.7% and 12.3%) and highest in the summer (21.3%).

1.4.2.3 Other Invertebrate Species

There are several other dominant invertebrate species found in Lake Tahoe. Many are relatively small and cryptic (i.e., camouflaged), making them difficult to see and identify. These include the pea clam (*Pisidium* spp.), the Tahoe stonefly (*Capina lacustra*), Midge (Family Chironomidae), and the blind amphipod (*Stygobromus tahoensis*). Additionally invasive New Zealand mudsnail (*Potamopyrgus antipodarum*) has been found in areas around the mouth of the Truckee River (Tahoe Regional Planning Agency https://www.trpa.gov/new-zealand-mudsnail).

1.4.3 Fishes

Fishes in Lake Tahoe can be characterized as those that live in the pelagic, offshore regions, of the lake and those that inhabit the nearshore and benthic areas. Each group is made up of various species.

1.4.3.1 Offshore Fishes

Lake Tahoe is currently home to native and introduced Salmonids, which represent the majority of its offshore fish diversity. These include the native Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*) and mountain whitefish (*Prosopium williamsoni*) as well as introduced lake trout (Mackinaw) (*Salvelinus namaycush*), rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and Kokanee salmon. The native Tui chub (*Siphateles bicolor*) represents the only non-salmonid offshore fish species.

Lake Trout/Mackinaw

Lake trout (*Salvelinus namaycush*), colloquially Mackinaw, were originally stocked into Lake Tahoe in 1888 to augment the local sport fishery. They established a self-sustaining population by the early 20th century which persists to the present day, supporting the sport fishery (Frantz and Cordone 1970). Historically, forage fishes and crayfish were the main prey of lake trout in the lake (Frantz and Cordone 1970), however after the establishment of freshwater shrimp (*Mysis relicta*) it has been reported that only larger trout greater than 58 cm in length exhibit piscivory on forage fish (Tui chub, mountain whitefish, Tahoe sucker), with smaller lake trout feeding almost exclusively on Mysis (Vander Zanden et. Al. 2003).

Brown Trout

Brown Trout (*Salmo trutta*) were first observed in Lake Tahoe in 1884 (USGS 2024) after deliberately being stocked into the system to augment the sport fishery. Brown trout are a cold-water species able to inhabit streams, rivers, and lakes. With a typical lifespan of 5-6 years, up to over 10 years depending on habitat (NPS 2024), maturity in landlocked populations occurs in 2-4 year. Spawning occurs in late fall to early winter in rivers and tributaries. Considered sight feeders (Greer et al. 2015), brown trout occupy a wide trophic niche which can consume benthic invertebrates, crustaceans, and fish (USGS 2024), typically staying closer to shore than other Salmonids (Lake Ontario; Nettles et. Al. 1987).

Rainbow Trout

Rainbow trout (*Oncorhynchus mykiss*) were introduced into Lake Tahoe in the 1880's to increase the sport fishery. Typically, large lake rainbow trout spawn in early to late spring in lake tributaries where their offspring reside and grow for about 1 year before returning to the Lake, in which they reach maturity in 2-4 years (USGS 2024). In the littoral zone of Lake Tahoe, during the summer months, rainbow trout have been shown to most often be associated with complex cobble and boulder habitats (Beauchamp et al 1994). Rainbow trout can take advantage of both pelagic and littoral-benthic habitats and resources with one study finding that resource partitioning is dependent on population density (Stiling et al. 2021).

Tui Chub

Tui chub (*Siphateles bicolor*) represents the only native pelagic minnow (Cyprinid) in Lake Tahoe. Commonly found throughout western North America, Tui chub are highly adaptable and can be found in habitats ranging from fast moving streams to large lakes (Calfish.ucdavis.edu 2024). Tui chub typically spawn in late April to early August, with peak spawning in Pyramid Lake (another subalpine lake) occurring in June (Calfish.ucdavis.edu 2024). Spawning occurs in the shallows, with females showing preference for sandy substrates with vegetation. Hatchlings are pelagic feeders, young fish mostly feed on invertebrates, and while maturing they are able to switch diets to include plants and algae (Calfish.ucdavis.edu 2024). Tui chub are a primary forage fish for many of the offshore Salmonids in Lake Tahoe.

Lahontan Cutthroat Trout

Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*) were extirpated from Lake Tahoe in the 1930's due to overfishing, non-native species introductions, and habitat degradation (Vander Zanden et. Al. 2003). Reintroduction efforts are ongoing through targeted stocking, though current populations exhibit low abundance.

Kokanee Salmon

Kokanee (*Oncorhynchus nerkaare*) are the non-anadromous "land locked" form of sockeye salmon. Adults averages 9-12 inches, though they can grow up to 20 inches in quality populations (Washington Department of Fish and Wildlife 2024). Kokanee are an important food source for lake trout (Frantz and Cordone 1970). Kokanee typically live in lakes for 4 years before returning to their natal streams (Taylor Creek in Lake Tahoe), where they spawn and die (Beauchamp et. Al. 1994).

Mountain Whitefish

Mountain whitefish (*Prosopium williamsoni*) are a widely dispersed salmonid of western North America which commonly inhabit the nearshore zone of Lake Tahoe (Beauchamp et. Al. 1994).

1.4.3.2 Nearshore and Benthic Fishes

While several species of fishes are found in the nearshore and benthic regions of Lake Tahoe, only a few are commonly found along the open lake shoreline. These include the Tahoe sucker (*Catostomus tahoensis*), the speckled dace (*Rhinichthys osculus*) and the Paiute sculpin (*Cottus beldingii*). Others are rare or inhabit only specific areas such as inlets, backwaters, and bays.

Tahoe Sucker

The Tahoe sucker is found in freshwater lakes, streams, and reservoirs within the northeastern Sierra mountains. They rarely exceed 15 cm in length. The life span of a Tahoe sucker is typically less than or equal to 5 years (Peacock et al. 2016). In lakes, Tahoe suckers grow to greater sizes by foraging along the bottom, sometimes as deep as 300 m. Juvenile Tahoe suckers typically occupy slow shallow regions of the water column while the adult suckers live in deeper pools that provide overhead cover from predators (Moyle 2002, University of California 2024). Tahoe suckers are considered omnivorous and within Lake Tahoe a sucker's diet might consist of midge larvae, annelid worms, and amphipods (Peacock et al. 2016). Adults tend to feed mostly at night on algae, detritus (debris), and various forms of benthic invertebrates, while juveniles feed on zooplankton and other organisms found in or around algae and aquatic vegetation (Moyle 2002).

In terms of distribution, Tahoe suckers can show seasonal movements between lakes and streams (Moyle 2002). As for daily movements, since they are nocturnal feeders, they can be found resting closely packed together around banks and other forms of cover (Moyle 2002).

Speckled Dace

The speckled dace (*Rhinichthys osculus*) is a very adaptable cold-water species preferring clear, well oxygenated water, and can be found in small springs to cold alpine lakes such as Lake Tahoe (Calfish.ucdavis.edu 2024). In lakes, speckled dace feed opportunistically on zooplankton, algae, and insects (Calfish.ucdavis.edu 2024). With a typical lifespan of 3 years (up to 6), speckled dace reach maturity in their second year, when they spawn in the shallow gravelly littoral regions of lakes and tributaries during the summer (Calfish.ucdavis.edu. 2024). Predation and competition with introduced warm water species has decreased speckled dace abundance in the Tahoe Keys (Kamerath et. Al. 2008)

Paiute Sculpin

The Paiute sculpin (*Cottus beldingii*) are a benthic dwelling fish that live in cold-water streams and lakes not warmer than 77 °F (25 °C) (Calfish.ucdavis.edu 2024). Paiute sculpin's diet varies dependent on depth in Lake Tahoe. The deepwater variety feeds mainly on algae and detritus supplemented by other prey items, while the shallow water forms focus on benthic invertebrates, e.g., chironomid midge larvae (Ebert and Summerfelt 1969; Calfish.ucdavis.edu 2024). They reach sexual maturity at 2-3 years and spawn in nests over gravel and rocky substrate from May to June (Calfish.ucdavis.edu 2024). Paiute sculpin are an important trophic link in Lake Tahoe due high predation by Salmonids (Lake Trout) and their feeding on lower trophic organisms and detritus (Ebert and Summerfelt 1969).

Other Nearshore and Benthic Fishes

Several other fishes inhabit Lake Tahoe. Many are relegated to small areas or are rarely observed. These include the native Lahontan redside (*Richardsonius egregius*), and the introduced catfish (*Ictalurus punctatus*), bluegill sunfish (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and goldfish (*Carassius auratus*).

1.5 Impacts of Lead to Aquatic Receptors

Lead is considered a toxic metal contaminant when present in biotic and abiotic environments and takes several different forms. Each of the forms of lead can have different modes of action and bioavailability when it enters the aquatic environment. Exposure to lead concentrations in freshwater environments can present different levels of ecological risk. Exposure to dissolved concentrations of lead, particularly the free ion (Pb^{2+}), readily passes across cell membranes including gills, epidermis, and gut tissues. Additionally, lead ions can displace calcium during the synthesis and development of bones, teeth, and shells. The resulting exposure can lead to bioaccumulation of lead into tissues of organisms where concentrations may persist and be transferred across trophic levels through consumption of prey items. Bioaccumulation of lead can cause additional tissue stress.

Depending on the exposure route or length of exposure, lead toxicity can be both acute or chronic. Exposure to high levels of lead can lead to "acute" or lethal toxicity within relatively short time spans (i.e., minutes to days). Exposures to lower levels or for long periods can lead to chronic toxic effects such as decreased reproductive output or physical abnormalities. The USEPA has evaluated lead toxicity in freshwater environments and published acute and chronic ambient water quality criteria (AWQC; USEPA 1985). The lead AWQC for the protection of aquatic life is based on multiple toxicity studies that include many species. The published AWQC are considered conservative estimates of concentrations that are indicative of toxic levels. In waters, the acute AWQC for lead is 65 µg/L, while the chronic AWQC for lead toxicity is 2.5 µg/L (USEPA 1985).

However, lead toxicity is dependent on water hardness. The published AWQC are based on an assumed hardness of 100 mg/L as calcium carbonate. The USEPA (1985) provided calculations to derive site-specific acute and chronic AWQC based on hardness for lead. Formula 1 below shows the formula to calculate hardness-dependent lead acute AWQC and Formula 2 shows the hardness-dependent lead chronic AWQC formula.

Formula 1:

$$Acute\ Concentration\ Value = e^{1.273[\ln(hardness)]-1.46}$$

Formula 2:

$$Chronic\ Concentration\ Value = e^{1.273[\ln(hardness)]-4.705}$$

Lake Tahoe is known to have lower hardness than typical surface waters due to local geology. Most available hardness data for Lake Tahoe waters that have been published are based on well water sources. This is not generally indicative of ambient lake water. The Annual Water Quality Report for the Tahoe City Public Utility District (2022) measured hardness at a lake intake source in the lake. The measured value for hardness (as calcium carbonate) was reported as 29 mg/L. Therefore, using the above formulas, the site-specific acute and chronic concentration values for Lake Tahoe are 16.89 µg/L and 0.66 µg/L, respectively.

For exposure to lead in sediments, the National Oceanic and Atmospheric Administration (NOAA) published a meta-analysis of established acute and chronic toxicity reference values for a wide range of contaminants including lead in both marine and freshwater sediments (NOAA Screening Quick Reference Tables [SQuiRT]; Buchman 2008). For freshwater

sediment, this included eight published values that were developed from laboratory toxicity tests, using a variety of species as receptors.

- ARCS: Assessment and Remediation of Contaminated Sediments (EPA 905-R96-008); calculation and evaluation of sediment effect concentrations for amphipod and midge (*Hyalella Azteca* and *Chironomus Riparius*)
- TEC: Threshold effect concentration, concentration below which adverse effects are unlikely to occur (Arch ET&C 2000); development and evaluation of sediment quality guidelines for freshwater systems
- TEL: Threshold effect level, represents the concentration below which adverse effects are expected to occur only rarely (Arch ET&C 2000); development and evaluation of sediment quality guidelines for freshwater systems
- LEL: Lowest effect level, no effects on the majority of sediment-dwelling organisms are expected below this concentration (Guidelines for the protection and management of aquatic sediment quality in Ontario, 1993)
- PEC: Probable effect concentration, the concentration of a contaminant in sediment expected to adversely affect benthic biota, (Arch ET&C 2000); development and evaluation of sediment quality guidelines for freshwater systems
- PEL: Probable effect level, represents the concentration above which adverse effects are expected to occur frequently (Arch ET&C 2000); development and evaluation of sediment quality guidelines for freshwater systems
- SEL: Severe effect level, indicating the level at which pronounced disturbance of the sediment-dwelling community can be expected (Guidelines for the protection and management of aquatic sediment quality in Ontario, 1993)
- UET: Upper effects threshold (Buchman 1999)

The NOAA tables (Buchman 2008) also provide "background" concentrations for lead in sediments found in the United States. Published background concentrations range from 4 to 17 mg/Kg. Ecological toxicity thresholds for lead range from 31 to 250 mg/Kg in freshwater sediments. Concentrations of lead in waters below the AWQC, or below the NOAA sediment toxicity thresholds would be considered not to elicit an ecological risk to aquatic life.

1.6 Ecological Risk Assessment Methodology

This chapter details the framework executed for this ecological risk assessment (ERA) (Figure 3). I used this framework to characterize risk associated with the differing facets of lead exposure. I identified key receptors and endpoints associated with this ERA by conducting research on the environmental setting of Lake Tahoe.

1.6.1 Ecological Risk Framework

This ERA followed established procedures to evaluate and organize data, assumptions, and uncertainties to help comprehend and effectively predict relationships between stressors and ecological responses (USEPA 1998). The objective of this ERA was to evaluate the potential for adverse impacts on the surrounding ecological community as a result of associated exposures to lead either through water or sediment. Consistent with established guidance, a tiered ERA approach was used. The overall framework is illustrated in Figure 3.

Each tier of the ERA process is progressively a more sophisticated evaluation of risk. Triggering the next tier requires additional analysis and resources which are applied to reflect increasing characterization of variability and/or uncertainty in the risk estimate that will contribute to decision-making. Benefits to a tiered approach include:

- Opportunities for input and direction from decision-makers;
- A stepwise approach for compiling and analyzing site-specific information and incorporating a more realistic assessment of exposure effects;
- Opportunities to streamline the ERA effort at each tier; and
- Opportunities to eliminate from further consideration areas, chemicals, and receptors for which there is an "acceptable" level of risk.

If data are sufficient, contaminants and areas that are introduced to the ERA process at Tier 1 may exit the process at the conclusion of any tier provided the results indicate:

- Acceptable levels of risk exist;
- A remedy is chosen to reduce ecological risks to acceptable levels; or
- No further action has been approved by the project proponent and regulatory bodies.

A scientific/management decision point exists at the conclusion of each tier, when it is imperative to determine:

1. Whether or not the risk assessment, at the current stage, is sufficient to support sound decision-making; and
2. If the assessment is determined to be insufficient, whether or not refinement of the current tier or progression to the next tier would provide benefit which would warrant the extra effort.

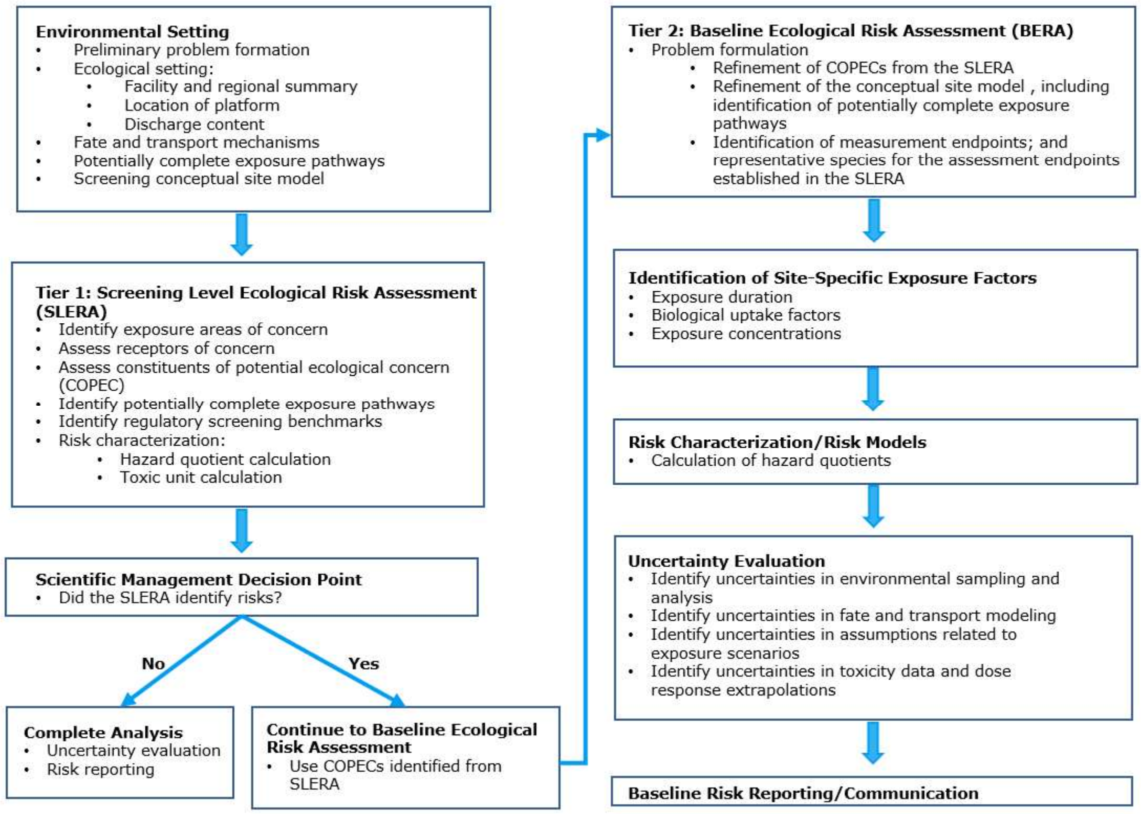


Figure 3: Ecological Risk Framework

Source: USEPA 1998

1.6.2 Screening Level Ecological Risk Assessment

The Screening Level Ecological Risk Assessment (SLERA) is included early in the ERA process to establish whether the conditions outlined in the data have potential for adverse ecological impacts. This tier is aimed at incorporating site-specific data and fundamental qualitative analyses to effectively use resources.

An initial step in the SLERA is to execute a comparison of collected data within exposure areas to published ecological screening benchmarks with the intent of identifying the constituents (if any) that would activate further evaluation in a Baseline Ecological Risk Assessment (BERA).

As the first tier of the ERA process, it is crucial to ensure the assessment is not unjustly concluding that there is no risk, when risk does exist. To prevent this error, where data are limited or lacking, SLERA assumptions are designed to consistently overestimate the potential for risk using the higher (i.e., worst case) concentrations in the evaluation.

1.6.3 SLERA Problem Formulation

Formulation of the SLERA problem for this ERA identified the crucial factors to be considered and ensured that the ecological receptors chosen are likely to be exposed and the most likely exposure scenarios to contribute to ecological risk were evaluated. The SLERA problem formulation effort was successful in:

- Identifying exposure areas of concern;
- Assessing the extent to which receptors of concern were present;
- Assessing the extent to which Constituents of Potential Ecological Concern (i.e., lead) were present; and
- Identifying potentially complete exposure pathways.

Exposure areas of concern are defined as the spatial area where the concentration of a constituent of concern (i.e., lead) is predicted to occur, and if those areas support (or are suitable to support) receptors of concern.

Both graphical and box Conceptual Site Models (CSMs) were developed to identify and summarize the sources, mechanisms of transport, media of concern, exposure routes, and receptor groups/trophic levels for each SLERA exposure area. The receptors considered in the Lake Tahoe SLERA problem formulation included:

- Aquatic plants/algae (primary producers);
- Macro benthic invertebrates (primary and secondary consumers);
- Benthic invertebrates (primary consumers); and
- Fish (primary and secondary consumers).

The routes of exposure considered in this ERA include:

- Dermal/direct contact;
- Incidental ingestion; and
- Ingestion.

1.6.3.1 Lake Tahoe Receptors

The graphical and box-model CSMs were prepared (Figure 4 and Figure 5) to describe the complete exposure routes for each receptor group included in the SLERA, such as:

- Biological uptake of chemicals of concern (in this case lead) in surface water by aquatic plants (primary producers), aquatic invertebrates (primary and secondary consumers), and fish (primary and secondary consumers);
- Incidental ingestion of constituents by aquatic invertebrates and fish (primary and secondary consumers); and
- Ingestion of constituents in aquatic food items by fish (secondary consumers).

The predominant exposure pathways for Lake Tahoe aquatic receptors for this ERA was ingestion of lead and uptake of dissolved lead in biota.

Screening benchmarks were obtained from the USEPA and NOAA SQuiRT (Buchman 2008). The SQuiRT presents the screening concentrations for inorganic and organic contaminants. For the purposes of this SLERA, literature was also reviewed to assess the impacts of lead on Lake Tahoe biota. (see Section 2.2.1). Additionally, NOAA's Chemical Aquatic Fate and Effects (CAFE) database (https://response.restoration.noaa.gov/cafe) was used to develop a more comprehensive predicted no-effect concentration (PNEC) for dissolved lead using a species sensitivity distribution (SSD) approach.

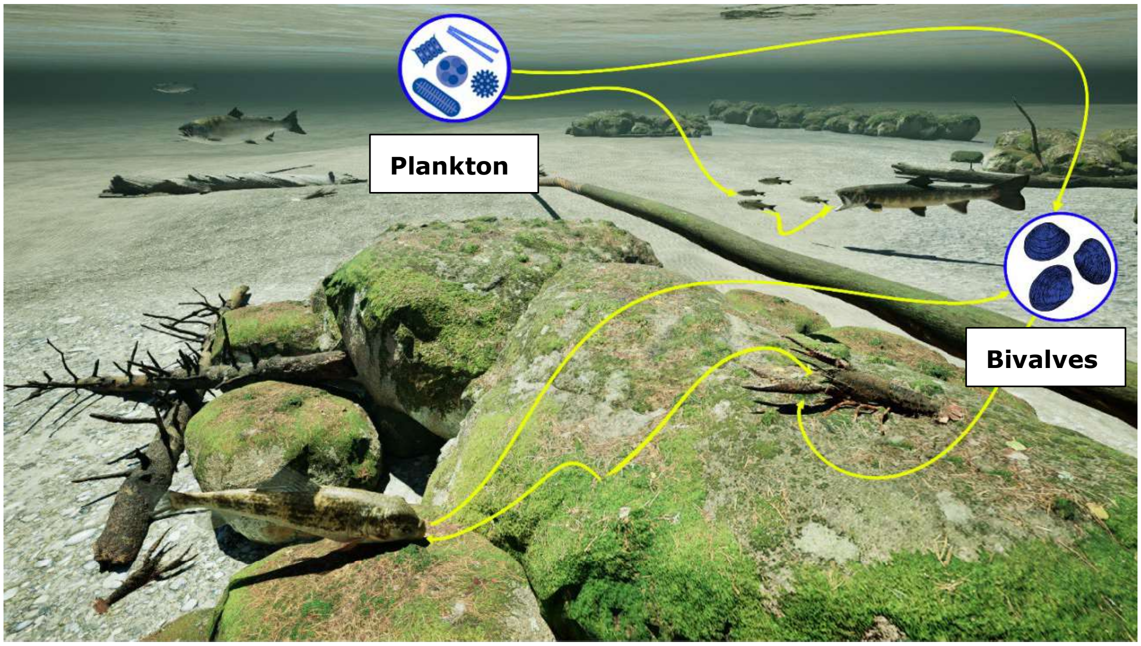


Figure 4: Graphical Conceptual Site Model

Note: Yellow lines represent exposure pathways to Lake Tahoe Biota.

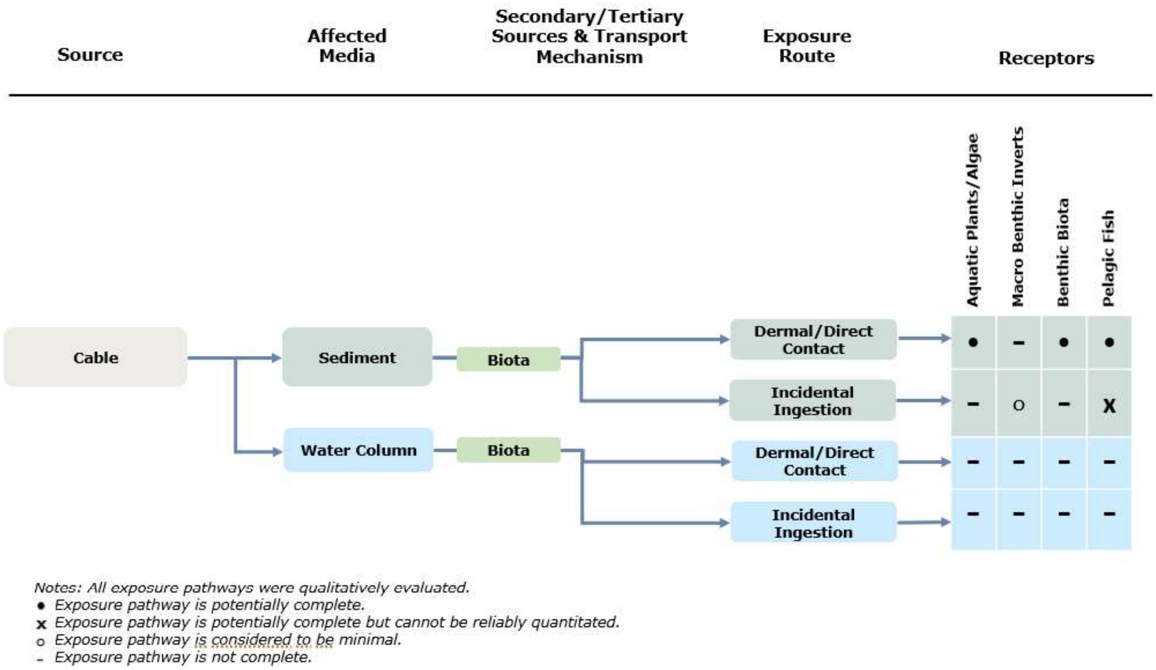


Figure 5: Box-Model Type Conceptual Site Model

1.6.4 Screening Benchmarks

Aquatic life screening benchmarks were established by regulatory bodies and include the USEPA AWQC (1985) to protect aquatic life from potential discharges of toxicants to the aquatic environment. According to the USEPA, utilizing aquatic life screening benchmarks in a SLERA is industry best practice (USEPA 1998). Aquatic life screening benchmarks are toxicity values above which risk may be present to aquatic life. 'Aquatic life' includes aquatic plants and algae, aquatic invertebrates, and fish. As such, the aquatic life screening benchmarks aid in identifying potential risks to those organisms. During the SLERA screen, aquatic life screening benchmarks were recorded for lead.

1.6.5 Risk Characterization

Results from the exposure and effects assessments were combined to understand the relationship between the environmental concentrations of contaminants and the potential adverse biological effects. To characterize risks to the Assessment Endpoints, the risk characterization step for the SLERA compares the results of the exposure and effects assessments to established toxicity benchmarks for various media and species. In this evaluation, the values from the laboratory data for both water and sediment samples collected in Lake Tahoe were compared to the screening toxicity benchmarks to determine the presence of risk.

1.6.5.1 Uncertainty Evaluation

A critical aspect of the ERA process is identifying and assessing the uncertainties that exist in the data and models used in the risk assessment process. The purpose of the uncertainty evaluation is to identify the key assumptions and data gaps associated with the analyses performed to ensure accurate interpretation of the risk assessment results.

Risk estimates were calculated through inspecting site data, assumptions about receptor exposures to environmental media such as water and sediment, and available toxicity data. The uncertainties in the risk assessment approaches used for Lake Tahoe were grouped into four main categories: (1) uncertainties in environmental sampling and analysis; (2) uncertainties in fate and transport modeling; (3) uncertainties in assumptions related to exposure; and (4) uncertainties (i.e., variability in lab results, extrapolations within species, etc.) within toxicity data.

1.6.6 SLERA Scientific Management Decision Point

Upon completion of the SLERA evaluation, a scientific management decision point was available to assist with informing whether additional steps would need to be conducted in the ERA process (Figure 3). The scientific management decision point was based on the following questions:

1. Did the SLERA results readily provide information sufficient to support decision-making (i.e., did the SLERA identify potential risk)?
2. If the SLERA identified potential risk from the constituents in question, was further refinement of risk necessary in the BERA phase?

According to the previously referenced guidance documents, if no risk is identified in the Tier 1 SLERA stage, then a Tier 2 BERA phase is not required, and the ERA ends at the SLERA stage.

1.6.7 Baseline Ecological Risk Assessment

When contaminant exposure concentrations are found at levels above the screening benchmarks in the SLERA, the BERA process is a systematic approach that ensures a thorough and quantitative evaluation of ecological risks, guiding environmental professionals in protecting ecological resources and public health (USEPA 1997, USEPA 2001). As shown in Figure 3, the framework for the ERA included the scientific management decision point step prior to determining if a BERA is triggered. The BERA is only initiated when risks are identified in the SLERA and if none are identified, a BERA is not warranted, and the ERA is complete.

As explained below, a BERA was not warranted for Lake Tahoe water and sediment concentrations because the SLERA did not identify any water or sediment concentrations that exceeded toxicity screening benchmarks.

1.7 Observational Data

I have completed both direct and indirect observations of the telecommunication table and surrounding habitat. This included first-hand visual observations of the cable during sampling efforts in 2023 (Ramboll 2023 a, b). Additionally, I reviewed over 10.5 hours of reconnaissance videos collected in March 2022 by divers. Both first-hand and video observations included Cable A and Cable B locations along the periphery of Lake Tahoe.

The area around the cable can be characterized as primarily sand, cobble, and boulders with many sunken trees and woody debris scattered throughout the area. The habitat on and around the telecommunication cables consists of a bacterial biofilm, associated algae, and some fishes. Where sand is prevalent evidence of a robust bivalve population exists.

The cable is generally intact with some areas that have obviously been cut. Other areas exhibit some superficial damage to the outer covering but do not appear to penetrate the waterproofing. In several places the outer cable covering is gone, and the protective steel wrapping is exposed. Only in the areas where the cable was cut is the inner lead sheath exposed, and in those areas only for a small amount (i.e., less than about a foot). There are no observations of any other lead exposure.

Figure 6 (A-E) show various screen capture images showing representative areas of both Cable A and B.

Figure 6A: Bivalve Bed as Indicated by the Pockmarks on the Sand Surface and Associated Fecal Piles (Brown Areas on the Sand) Along Buried Cable Route.

Figure 6B: Algae and Biofilm on Exposed Cable and Boulders

Figure 6C: Trout Near Sunken Log Near Cable

Figure 6D: Cable Emerging From Sand

Note: Pockmarks on sand indicate bivalve presence

Figure 6E: Cut End of Cable Showing Exposed Lead Sheath in Emerald Bay.

Note: Tubes with orange tops were used for sediment collections (Ramboll 2023b).

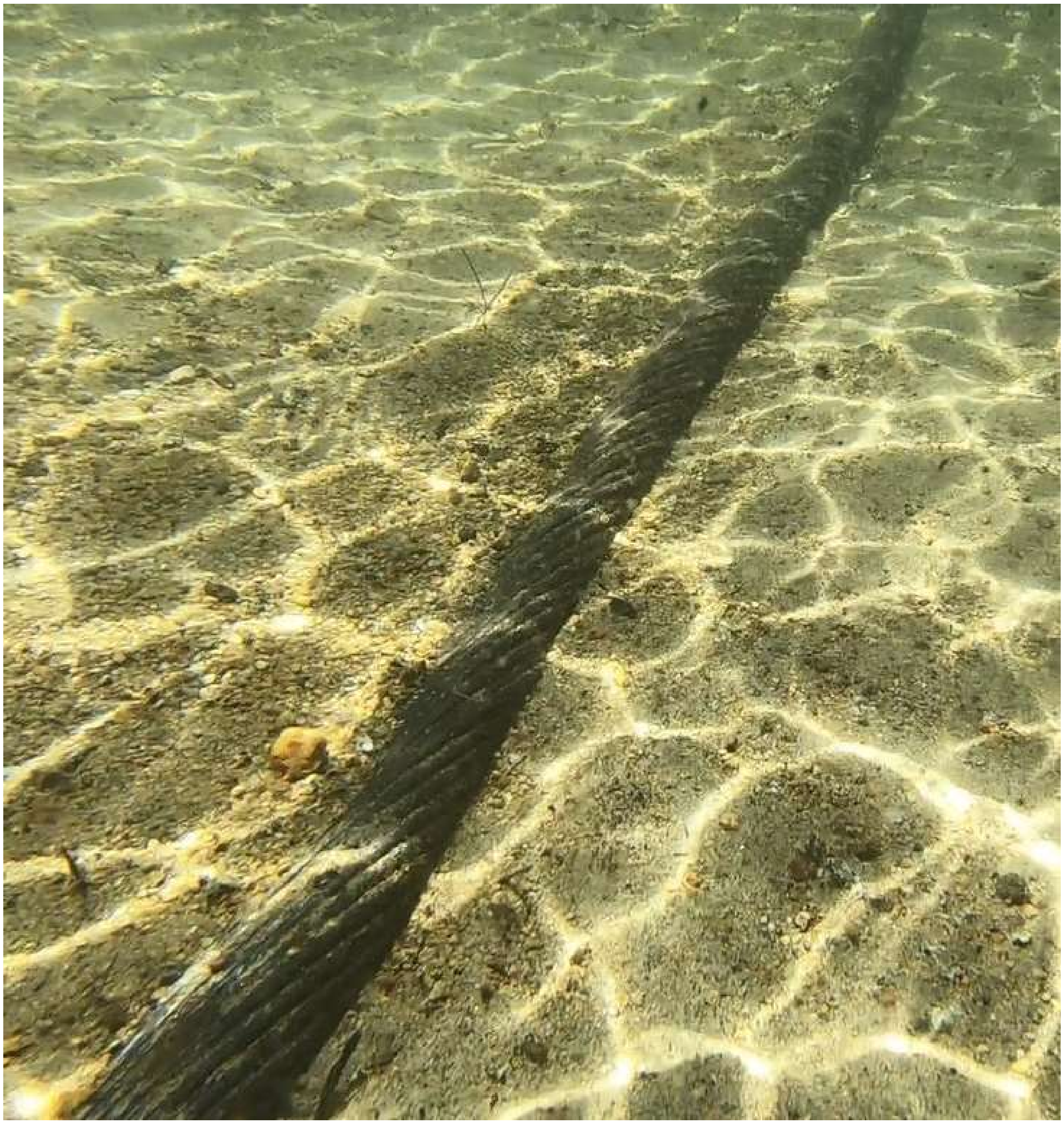


Figure 6F: Cable in Emerald Bay Over Sandy Bottom.

Note: Outer cable covering is eroded away, but waterproofing appears intact between steel protection strands.

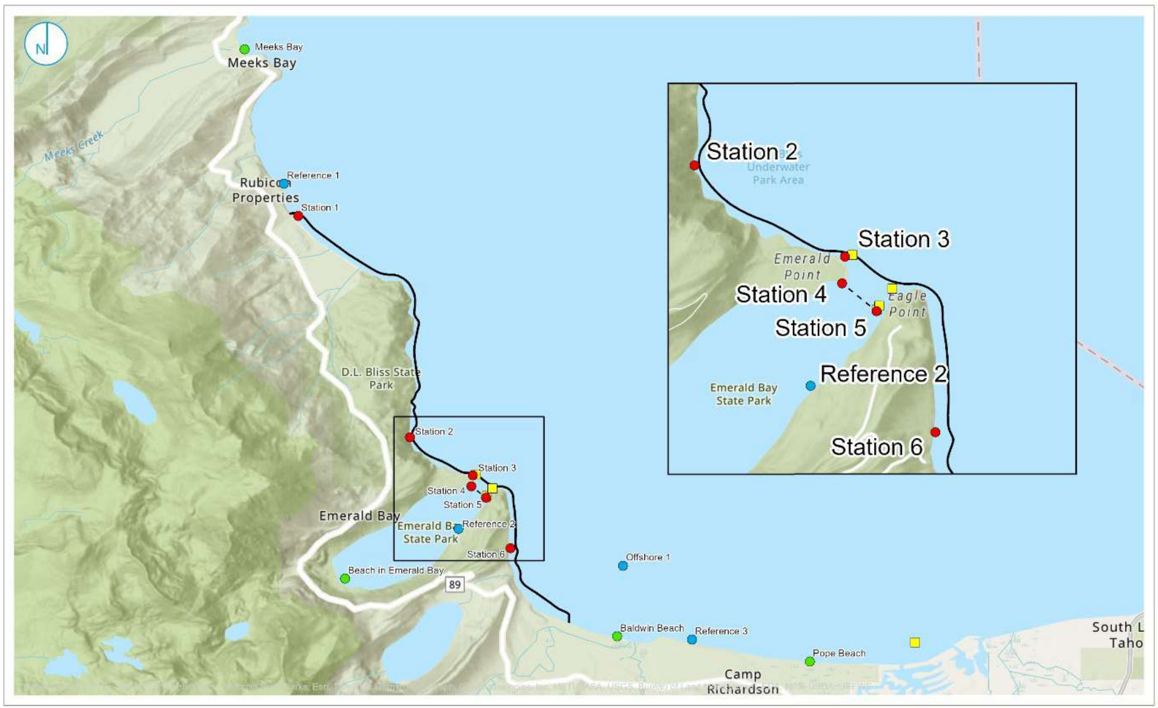
2. OPINIONS

2.1 Opinion 1: There is no ecological risk to aquatic receptors in Lake Tahoe from lead-clad telecommunication cables.

The evidence shows there is no ecological risk to aquatic receptors from lead in Lake Tahoe from the telecommunication cables. This is true for both water and sediment exposure pathways. Studies were completed that measure the total and dissolved lead concentrations within water samples collected just above the cable, while sediment samples included total lead in sediments. All studies included reference stations located away from the cable. Water and sediment concentrations were below accepted ecological risk thresholds indicating that there is no ecological risk to aquatic organisms, as explained for each media in the following Opinions 1A and 1B.

2.1.1 Opinion 1A: There is no ecological risk to aquatic receptors in Lake Tahoe from lead found in waters near the telecommunications cables.

Two studies were completed to evaluate water and sediment lead concentrations in Lake Tahoe (Haley and Aldrich 2021, Ramboll 2023a, 2023b). Each study included sampling at various lake water stations. The Haley and Aldrich study included water samples near the cables and at reference stations away from the cables. The Ramboll studies included water samples near the cable, reference stations away from the cable, and shallow beach samples. Figure 7 shows the location of each sample in each study.



- - Cable A
— Cable B
Haley & Aldrich (2021) Sample Locations

Ramboll Sample Locations
Beach Sample Location
Reference Station
Sample Station

Type of Sample Collected
Station 1, 4, 5, and 6 - Water and Sediment
Station 2 and 3 - Water Only
All Reference Stations - Water and Sediment
All Beaches - Sediment Only

0 2,500 5,000 Feet

SAMPLE LOCATIONS

Lake Tahoe, California

RAMBOLL US CONSULTING, INC.
A RAMBOLL COMPANY

RAMBOLL

Figure 7: Ramboll and Haley & Aldrich Sampling Locations

In the study performed by Haley and Aldrich (2021), water samples were collected at a distance of approximately 4 to 6 inches from the cables. Two samples were collected at cable locations, while three samples were collected at reference locations. Analysis of total and dissolved lead showed that all samples near the lake bottom and cable had non-detectable lead concentrations. Each sample was found to be below the laboratory method detection limit (MDL) of 0.043 µg/L. The MDL is the minimum measured concentration of a substance that can be reported with 99% confidence that the concentration is distinguishable from the method blank results. Utilizing accepted ecological risk SLERA methodology (see Section 1.6) and comparing observed concentrations to USEPA (1985; Buchman 2008) published lead AWQC of 65 µg/L for acute toxicity and 2.5 µg/L for chronic toxicity, and the calculated site-specific hardness-dependent AWQC of 16.89 µg/L (acute) and 0.66 µg/L (chronic), it is clear that concentrations found in Lake Tahoe by Haley and Aldrich (2021) do not pose an ecological risk. All concentrations of lead in Lake Tahoe waters were several orders of magnitude lower than the AWQC.

Similarly, Ramboll (2023a) performed a comprehensive study of water concentrations at six cable locations, four reference locations, and one offshore lake sample. At each station water samples were collected just above (i.e., within 6 inches of) the cable or lake bottom. The Ramboll study included laboratory analysis of both total and dissolved lead in water samples with an ultra-low laboratory MDL of 0.006 µg/L. In this study, dissolved lead was ND at the MDL at four stations (i.e., less than 0.006 µg/L). At one station, lead was detected and reported with an estimated value (i.e., detected between the laboratory method limit and the MDL). Estimated values are designated at the laboratory with a "J-Flag" to indicate that lead is detected but the concentration cannot be accurately reported. At one station located near exposed lead from a cut end of Cable A, dissolved lead was detected at 0.038 µg/L. Dissolved lead was not detected at the MDL at all of the reference stations and at the offshore station. Total lead was found at estimated concentrations at four stations ranging from J-flagged estimated values of 0.009 to 0.012 µg/L. Total lead found near the cut end of Cable A was found at 0.054 µg/L. Two reference locations and the offshore station had non-detectable lead at the MDL, while two reference locations had J-flagged estimated total lead concentrations of 0.010 and 0.011 µg/L respectively. As with the Haley and Aldrich (2021) study and using the USEPA SLERA process, lead concentrations in Lake Tahoe water were compared to the freshwater lead acute and chronic AWQC (USEPA 1985) and calculated site-specific hardness-dependent AWQC. In the Ramboll study, none of the lead samples were found above published AWQC (USEPA 1985) for freshwater organisms (65 µg/L for acute toxicity and 2.5 µg/L for chronic toxicity), or the calculated site-specific AWQC of 16.89 µg/L (acute) and 0.66 µg/L (chronic), indicating no ecological risk to aquatic organisms from lead concentrations in Lake Tahoe.

These studies and the conclusions based on them are further supported by recent advances in the development of water quality toxicity benchmarks for dissolved lead. In April 2024, NOAA updated its evaluation of how AWQC can be used in ecological risk assessment (https://response.restoration.noaa.gov/cafe). Using the SSD method, NOAA has developed an online calculator that utilizes multiple species toxicity data to better estimate the PNEC for dissolved lead. The SSD method utilizes multiple species and multiple toxicity test results to generate a distribution of results to provide a more accurate estimation of the PNEC. This is expressed as a hazard concentration. The PNEC is generally defined as the fifth percentile of all data (HC_5). This value is protective of 95% of all aquatic species. It requires at least five

different species distributions. Using the CAFE database and including toxicity studies covering 14 temperate aquatic species, the HC_5 was calculated to be 343.78 µg/L for acute aquatic toxicity (Figure 8; see Appendix B for CAFE inputs and full results). This indicates that for dissolved lead, the protective value (HC_5) is much higher than the USEPA acute lead toxicity value of 65 µg/L. Regardless of using the AWQC or the HC_5 method, all samples taken from Lake Tahoe are well below these toxicity values, indicating no ecological risk from lead in waters of Lake Tahoe. It should be noted that the SSD analysis and CAFE database do not contain sufficient information to generate a chronic value at this time.

Figure 8: Graphical Species Sensitivity Distribution for Dissolved Lead Exposure

Source: https://response.restoration.noaa.gov/cafe (see also Appendix B)

2.1.2 Opinion 1B: There is no ecological risk to aquatic receptors in Lake Tahoe from lead found in sediments near the telecommunications cables.

In 2023 Ramboll (2023b) collected sediment samples near both Cables A and B to investigate whether lead concentrations in sediments near the cable were indicative of any influence of the cable, as well as in a comparison to reference and public beach locations. Sediment sampling locations are shown in Figure 7.

Ramboll collected sediment samples at five different locations along the cables. At each location samples were collected at up to three distances (e.g., 0-0.15m, 1m, and 2m) from the cables. Additionally, sediment was collected from three reference locations away from the cables and four public beach locations. Results of this study showed that lead was found at all locations tested indicating that lead is a common element in the Lake Tahoe substrate. Lead concentrations at the stations closest to the cables (i.e., at a distance of 0-0.15m) ranged from 0.659 mg/Kg to 5.57 mg/Kg. Lead concentrations from three reference

locations ranged from 0.548 mg/Kg to 2.450 mg/Kg, while those at four public beach locations ranged from 0.920 to 1.400 mg/Kg.

The USEPA ecological risk assessment SLERA process was followed, and sediment lead concentrations were compared to eight published freshwater sediment quality toxicity benchmarks for aquatic receptors (Buchman 2008). These benchmarks range from 31 to 250 mg/Kg.

It is clear that all sediment lead concentrations found in the Ramboll 2023 study were far below the benchmarks. This indicates that there is no ecological risk to aquatic organisms from lead concentrations in Lake Tahoe sediments.

2.2 Opinion 2: Telecommunications cables are not contributing to elevated lead concentrations in Lake Tahoe waters or sediments.

Sediment and water lead concentrations measured in multiple studies show that the telecommunication cables in Lake Tahoe are not contributing to elevated lead concentrations in Lake Tahoe. Studies provided by Haley and Aldrich (2021) and Ramboll (2023 a, b) found no attributable ecologically relevant gradient in lead concentrations near the cable. Indeed, concentrations measured (both total and dissolved lead) in waters near the cable were not different than those found in reference locations away from the cable. Furthermore, Ramboll (2023b) showed that sediment lead near the cable was found in a similar concentration range to sediments at reference stations not potentially influenced by the cable. Most water samples in both studies were at such low concentrations to be below laboratory reporting levels (i.e., below the MDL), or were estimated concentrations (i.e., J-flagged). Sediment samples collected by Ramboll (2023b) at various distances away from the cable showed similarly low total lead concentrations and lack of gradient within 2 meters of the cable. Additionally, concentrations were similar in magnitude to reference and beach stations, further indicating that the cables are not contributing to elevated lead concentrations in Lake Tahoe.

2.3 Opinion 3: Observations also show no impact of lead from the telecommunication cables on aquatic resources or the ecology of Lake Tahoe

A detailed video survey was conducted by Marine Taxonomic Services, Ltd. and Below the Blue in March 2022 to document the status of the telecommunication cables. Over the course of 5 days, two divers collected over 10.5 hours of video that included a survey of both Cable A in Emerald Bay and Cable B along the southwest side of the Lake.

It is reasonable to assume that if the telecommunication cables were releasing lead at concentrations that impact aquatic ecological resources, there would be visible signs of such impact. This could be as subtle as an impact zone or “halo” effect of lower density around the cable where higher concentrations of lead would be expected or as overt as loss of habitat. I completed a detailed review of all video segments from each of the two divers from March 2022 This included over 10.5 hours of video and detailed observations of the physical condition of the cable, biota, and habitat noted along with representative still screen captures. Observations included numerous locations where superficial damage was observed to the outer waterproofing cover on Cable B and areas where Cable A was cut. At all of these locations there were no observable impacts to the abiotic or biotic systems. For example,

where biofilms and algae were present on the cable covering and rocks, no visible difference in presence or density was found through review of videos or during my first-hand observations. Bivalve populations were observed near the cable that were similar in density to those observed at distances away from the cable (see Figure 6A and D). It should be noted that quantitative evaluation of population size of infaunal organisms is not possible on video review. Taken together the video data support the conclusion that lead from the telecommunication cables is not impacting aquatic resources in Lake Tahoe.

2.4 Opinion 4: Based on multiple lines of evidence, there is no impact of lead from the telecommunication cables on aquatic resources of Lake Tahoe

Multiple lines of evidence lead to the conclusion that the telecommunication cables do not release lead in amounts deleterious to aquatic resources in Lake Tahoe, nor do they present an imminent and substantial endangerment to those resources. First, there is no ecological risk presented by water or sediment lead concentrations near the cable. Studies showed that ambient lead concentrations in water were orders of magnitude below USEPA lead AWQC. This was true for both total and dissolved lead concentrations. Additionally, all sediment concentrations found in Lake Tahoe were below published sediment lead toxicity benchmarks. Concentrations below benchmarks indicate a lack of ecological risk. Utilizing USEPA (1998) ERA methodology showed that there is no ecological risk from water or sediment lead concentrations in Lake Tahoe. Second, multiple studies (Haley and Aldrich, 2021, Ramboll 2023 a, b) found that there was not an ecologically relevant concentration gradient of lead around the cable in either water or sediment. This conclusion is evidenced by water samples collected above the cable and sediment samples collected at distances from the cable. Furthermore, Ramboll (2023b) showed that sediment lead near the cable was found in a similar concentration range to sediments at reference stations not potentially influenced by the cable. Finally, visual evidence shows that there is no evidence of impacts along the route of Cable A or B in Lake Tahoe. Taken together all lines of evidence show that the telecommunication cables are not leaching lead into Lake Tahoe and if any were released it is not in amounts deleterious to the aquatic resources in Lake Tahoe and does not present imminent and substantial endangerment to those resources.

3. LITERATURE CITED

Behnke, R.J. 2002. Trout and Salmon of North America. The Free Press, NY.

Beauchamp, D. A., Byron, E. R., & Wurtsbaugh, W. A. (1994). Summer Habitat Use by Littoral-Zone Fishes in Lake Tahoe and the Effects of Shoreline Structures. North American Journal of Fisheries Management, 14(2), 385–394.

Beauchamp, D. A., Budy, P. E., Allen, B. C., & Godfrey, J. M. (1994). Timing, distribution and abundance of kokanees spawning in a Lake Tahoe tributary. The Great Basin Naturalist, 54(2), 130–141

Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1. Seattle, WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration. 34 pp.

California Office of Environmental Health Hazard Assessment (OEHHA). 2023. The Proposition 65 List. https://oehha.ca.gov/proposition-65/proposition-65-list.

California Public Utilities Commission (CPUC). 2024. Consumer Confidence Reports. https://www.cpuc.ca.gov/industries-and-topics/water/consumer-confidence-reports.

Chandra, S., H. Segale, M. Wittmann S. Adler and L. Hennessy. 2010. "Current Food Web of Lake Tahoe". UC Davis Tahoe Environmental Research Center and University of Nevada Reno. currentfoodweb_v2.pdf (ucdavis.edu). Retrieved 2024-5-6.

Chien, C.T., B. Allen, N.T. Dimova, J. Yang, J. Reuter, G. Schladow, and A. Paytan. 2019. Evaluation of atmospheric dry deposition as a source of nutrients and trace metals to Lake Tahoe. Chem. Geo. 511: 178-189.

Dundas, Suzie. 2023. SF Gate. 'Super toxic': What a team found 500 feet below Tahoe's surface. https://www.sfgate.com/renotahoe/article/lake-tahoe-robot-hazardous-waste-cleanup-18406175.php.

Ebert, V.W. and Summerfelt, R.C., 1969. Contributions to the life history of the Paiute sculpin, Cottus beldingi, Eigenmann and Eigenmann in Lake Tahoe. Calif Fish Game, 55, pp.100-20.

Environmental Protection Agency (EPA). 2024. Learn about Lead. https://www.epa.gov/lead/learn-about-lead.

Flint, Warren R. 1977. Seasonal Activity, Migration and Distribution of Crayfish *Pacifastacus Ieniusculus,* in Lake Tahoe*.* The American Midland Naturalist, Vol. 97, No. 2, p.p 280-292. http://www.jstor.org/stable/2425094.

Frantz, Ted C. and Cordone, Almo J. 1970. Food of Lake Trout in Lake Tahoe. Reprint from California Fish and Game, 56(1): 21-35.

Greer, M.J.C., S.K. Crow, A.S. Hicks, and G.P. Closs. 2015. The effects of suspended sediment on brown trout (Salmo trutta) feeding and respiration after macrophyte control. New Zealand Journal of Marine and Freshwater Research 49(2):278–285. https://doi.org/10.1080/00288330.2015.1013140.

Haley and Aldrich. 2022. Investigation show legacy telecommunications cables are not affecting water quality in Lake Tahoe, California. White paper report prepared for AT&T. October 2021.

Heyvaert A, Naranjo, R, Melack J, Watanabe, S, Schladow G, Chandra S. 2022. Summary Science Report on Lake Tahoe Clarity and Associated Conditions, 2022. Tahoe Science Advisory Council (TSAC), June 2022. Incline Village, NV.

Incline Village Public Works. 2023. Water Quality Consumer Confidence Report 2023 for Calendar Year 2022.

Kingsbury General Improvement District. 2023. Consumer Confidence Report – 2023 Covering Calendar Year – 2022.

Kamerath, M., Chandra, S. and Allen, B.C., 2008. Distribution and impacts of warm water invasive fish in Lake Tahoe, USA. Aquatic Invasions, 3(1), pp.35-41.

Moyle, Peter B. 2002. Inland Fishes of California. Revised and Expanded. University of California Press. Berkley and Los Angeles, California. ISBN 0-520-22754-9.

Naranjo, R., Work, P., Heyvaert, A., Schladow, G., Cortes, A., Watanabe, S., Tanaka, L., and Elci, S. 2022. Seasonal and long-term clarity trend assessment of Lake Tahoe, California–Nevada: U.S. Geological Survey Scientific Investigations Report 2022–5070, 86 p., https://doi.org/10.3133/sir20225070.

National Park Service (NPS). 2024. Brown Trout – Shenandoah National Park (US National Park Service). https://www.nps.gov/shen/learn/nature/brown-trout.htm.

Nettles, D.C., James M. Haynes, Robert A. Olson, Jimmy D. Winter. 1987. Seasonal Movements and Habitats of Brown Trout (Salmo Trutta) in Southcentral Lake Ontario, Journal of Great Lakes Research, Volume 13, Issue 2.

Nevada Division of Environmental Protection (NDEP). 2020. State of Nevada Public Water Systems Annual Compliance Report for the Year 2020.

Noble PJ, Seitz C, Lee SS, Manoylov KM and Chandra S (2023) Characterization of algal community composition and structure from the nearshore environment, Lake Tahoe (United States). Front. Ecol. Evol. 10:1053499. doi: 10.3389/fevo.2022.1053499.

North Tahoe Public Utility District. 2021. North Tahoe Public Utility District Annual Water Quality Consumer Confidence Report for 2021.

Paytan, Adina and Rauch, Shannon. 2021. Trace metal concentrations of lake water, river water, and groundwater at Lake Tahoe from 2013 to 2016.

Peacock, Mary, Gustin, Mae, Kirchoff, Veronica, Robinson, Morgan, Hekkala, Evon, Pizzarro-Barraza, Claudia, Loux, Tim. 2016. Native fishes in the Truckee River: Are in-stream structures and patterns of population genetic structure related? Science of the Total Environment 563-564; 221-236.

Ramboll. 2023a. Lake Tahoe Water Lead Study, Lake Tahoe, California. Study report prepared for AT&T. July 31, 2023.

Ramboll 2023b. Lake Tahoe Sediment Lead Study, Lake Tahoe, California. Study report prepared for AT&T. August 24, 2023.

Restoring the Lake Depths Foundation. 2023. Summer 2023 Nets Over 5 Tons. https://restoremylake.org/.

Rhode Island Department of Environmental Management. 2017. Fact Sheet. Freshwater Aquatic Invasive Species in Rhode Island. Asian Clam.

Round Hill General Improvement District. 2022. Consumer Confidence Report – 2022 Covering Calendar Year – 2021. Shebley, W.H. 1917. History of introduction of food and game fishes into the waters of California. California Fish and Game 3:3-12.

South Tahoe Public Utility District. 2022. Consumer Confidence Report 2022 South Tahoe Public Utility District.

Susa, R., Antunes, C., and Guilhermino, L. 2008. Ecology of the Invasive Asian clam *Corbicula fluminea* (Müller, 1774) in aquatic ecosystems: an overview. Ann. Limnol. – Int. J. Lim. 2008, 44 (2), 85-94.

Stiling, Rebekah & Holtgrieve, Gordon & Olden, Julian. (2021). Population structure and habitat availability determine resource use by Rainbow Trout in high elevation lakes. Freshwater Science. 40. 10.1086/716184.

Washington Department of Fish and Wildlife. 2024. Species info: Kokanee. Washington Fish and Wildlife. Retrieved May 7, 2024.

Tahoe City Public Utility District. 2020a. Tahoe City Public Utility District 2020 Annual Water Quality Consumer Confidence Report.

Tahoe City Public Utility District. 2020b. Tahoe Utility District 2020 Tahoe Cedars Water System – Annual Water Quality Consumer Confidence Report.

Tahoe City Public Utility District 2020c. Tahoe City Public Utility District 2020 Madden Creek Water System – Annual Water Quality Consumer Confidence Report.

Tahoe City Public Utility District. 2020d. Tahoe City Public Utility District 2020 Timberland Water System – Annual Water Quality Consumer Confidence Report.

Tahoe Environmental Research Center. 2024. Scient to Save Lake Tahoe. Aquatic Invasive Species. University California Davis. https://tahoe.ucdavis.edu/ais.

Tahoe Regional Planning Agency. 2016. Wastewater Utility Service Areas. Lake Tahoe Region.

United States Environmental Protection Agency (USEPA). 1985. Ambient Water Quality Criteria for Lead – 1984. EPA 440/5-84-027. January 1985.

USEPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments Interim Final. Federal Register 63(93):26846-26924.

USEPA. 1998. Guidelines for Ecological Risk Assessment. Published on May 14, 1998. EPA 540-R-97-006.

USEPA. 2001. ECO Update. The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments. Publication 9345.0-14. EPA 540/F-01/014.

University of California. 2024. California Fish Species – Paiute Sculpin. Retrieved May 7, 2024. https://calfish.ucdavis.edu/species/?ds=241&uid=63.

University of California. 2024. California Fish Species – Speckled dace. Retrieved May 7, 2024. https://calfish.ucdavis.edu/species/?ds=241&uid=63.

University of California. 2024. California Fish Species – Tahoe Sucker. Retrieved May 7, 2024. https://calfish.ucdavis.edu/species/?uid=98&ds=241.

University of California Davis (UC Davis). 2022. Tahoe State of the Lake Report 2022. Tahoe Environmental Research Center.

United States Geologic Survey (USGS). 2024. NAS – Nonindigenous Aquatic Species. Rainbow Trout (Oncorhynchus mykiss) – Species Profile (usgs.gov). https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=910.

USGS. 2024. NAS – Nonindigenous Aquatic Species. Brown Trout (Salmo trutta) – Species Profile (usgs.gov). https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=931

Vander Zanden, Jake, Sudeep Chandra, Brant C. Allen, John E. Reuter, Charles R. Goldman Ecosystems, Vol. 6, No. 3 (Apr. 2003), pp. 274-288 (15 pages)

Zephyr Cove Water Utility District. 2023. Consumer Confidence Report – 2023 Covering Calendar Year 2022.

APPENDIX A
CV OF DR. PAUL R KRAUSE

RAMBOLL

ENVIRONMENT
& HEALTH

PAUL KRAUSE, PHD

Principal

Dr. Krause has over 30 years of experience in marine and aquatic ecology, toxicology, environmental impact analysis, environmental risk assessment, modeling, and regulatory permitting and negotiation. He is an internationally recognized expert in international permitting projects. His academic specialty is in marine ecology specializing in issues relating to the effects of large-scale industrial developments worldwide. His particular expertise revolves around development of multi-disciplinary teams for the management of large programs focused on marine and coastal environments. This includes development of port facilities, international impact assessments, emergency responses, decommissioning strategies, permitting, environmental studies, compliance, and agency negotiations. Dr. Krause has managed large impact and ecological assessments of marine and terrestrial receptors throughout the western United States, Gulf of Mexico, the Pacific Islands, Caribbean, Guyana, Thailand, Malaysia, Brunei, Indonesia Australia, and West Africa.

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EDUCATION

PhD, Ecology/ University of California, Santa Barbara, CA, USA, 1993

MS, Biological Sciences, California State University, Long Beach, CA, USA, 1987

BS, Marine Biology, California State University, Long Beach, CA, USA, 1984

CERTIFICATIONS/MEMBERSHIPS

- Sr. Professional Ecologist – Ecological Society of America
- Society of Environmental Toxicology & Chemistry (SETAC)
- Ecological Society of America (ESA)
- Society of Petroleum Engineers (SPE)
- Society of Ecological Restoration (SER)

KEY PROJECTS

LITIGATION AND SUPPORT SERVICES

Pipeline Spill Litigation, California

Supported litigation efforts related to a pipeline spill in southern California. This included evaluation of data related to ship collisions, pipeline ecological communities, organism growth and survival at offshore locations. Results of studies informed counsel to the nature

and extent of direct impacts associated with anchor hits to the pipeline.

Streambed Ecology Litigation, Colorado
Evaluated streambed ecological impacts related to potable water release in high mountain stream in Vail, Colorado. This included review of plaintiff expert reports, evaluation of data, investigation to the potential toxicological impacts of the release. Developed a technical report for defense counsel and participated in agency negotiations on settlement.

Offshore Decommissioning Litigation, California
Served as defense expert in evaluating contractual obligations, state of the science, and regulatory history for platform decommissioning obligations in the Santa Barbara Channel. Reviewed technical and regulatory documents, formulated opinion, and provided technical advice to counsel.

Wastewater Discharge Permit Litigation, Hawaii
Supported NPDES litigation related to permit conditions for discharges at several large municipal wastewater sites. Issues included bacteriological, toxicological, and nutrient aspects of promulgated NPDES permits issues by the State.

Groundwater Contamination Litigation, California
Served as a litigation expert for stream and bay communities contamination from chromium, PCB, and fluoride contamination from groundwater sources. Project involved development of field studies, interpretation of past studies, review and analysis of benthic ecological data, development of litigation support materials, and trial demonstrable materials.

PCB Litigation, New York
Provided litigation support services, project management, and strategic consulting. This project supported an imminent and substantial endangerment claim brought against the client. Managed trial depositions of experts, review of plaintiff’s expert reports, development of defense expert reports, and publication of trial demonstratives.

Drinking Water Litigation, California
Supported pending litigation regarding a TMDL related to a drinking water reservoir. Activities included the design of proposed field studies, review of regulations, regulatory negotiations, and strategic consulting.

ECOLOGICAL RISK ASSESSMENT

Marine Sediment Ecological Risk Assessment, California
Designed and carried out an ERA including SLERA and BERA for lead contamination in San Francisco Bay related to a shooting range where lead shot was found in marine sediments. The key receptor was diving ducks and benthic organisms. The focus of the ERA included development of cleanup goals. As part of this ERA represented the client (DOD) on the lead sediment BTAG committee.

Soils Lead Ecological Risk Assessment, California
Designed and managed large scale ERA including SLERA and BERA under Superfund guidance for the Fort Ord shooting range in California. This study focused on areas where rifle and pistol training ranges had been used for decades. Lead and copper levels from expended ammunition were sampled in soils. Ecological receptors included burrowing owls, small mammals, various birds, reptiles, and amphibians. As part of this ERA represented the client (US Army) on the BTAG committee for risk.

Marine Sediment Ecological Risk Assessment, California
In preparation for a property transfer, conducted the Ecological Risk Assessment using USEPA Superfund methodologies on effects of residual PCBs and metals on the terrestrial and marine

communities in Humboldt Bay, CA. This included a SLERA and BERA. The BERA was focused on marine sediment biota and coastal receptors

Mine Tailings Ecological Risk Assessment, Oregon

Conducted both SLERA and BERA level Ecological Risk Assessment on effects of mine tailings on a stream community at the Cornucopia uranium mine site in eastern Oregon. This particular site included field evaluations of tailings piles and stream bed communities. Ecological contaminants of concern included U, Pb, Cu, V, and Hg associated with the tailings. Ecological receptors included birds, bats, and aquatic species.

Produced Water Discharge Ecological Risk Assessments, Trinidad and Tobago

Designed and conducted multiple SLERA and BERA ecological risk assessments for offshore platform discharges of produced water and other platform associated discharges. Over 12 associated risk assessment have been completed. Contaminants of concern are PAHs and metals. Marine receptors include fishes, birds, mammals, turtles, and invertebrates. Where BERA has been required, detailed food web modeling is included.

Mercury, NORM, and Plastics Ecological Risk Assessment, Australia

Designed and conducted SLERA and BERA ecological risk assessment on pipelines and associated subsea infrastructure scheduled for decommissioning. The future looking ERA focused on sediment and water related risks. Contaminants were focused on mercury, NORM, and various plastic coatings from the pipelines. Receptors included marine fishes and benthic organisms.

Soils Ecological Risk Assessment, Montana

Supported the development and execution of SLERA and BERA level ERAs focused on remediation areas of the Anaconda Smelter in Montana. This study included terrestrial soils, plants and organisms as receptors with emphasis on food web modeling and exposure level calculations. Contaminants were primarily metals with an emphasis on Copper.

Decommissioning Human Health and Ecological Risk Assessment, Thailand

In anticipation of decommissioning of multiple platforms in the Gulf of Thailand, designed, managed, and developed a multi-faceted HHERA focused exclusively on mercury remaining in sediments from decades of produced water discharges. This study included fish tissue sampling, evaluation of fishing and local population centers for exposure, sediment benthic modeling, food chain modeling, and a detailed net environmental benefit analysis (NEBA).

Soils Ecological Risk Assessment, Montana

Supported the development and execution of SLERA and BERA level ERAs focused on remediation areas of the Anaconda mine areas near the Coeur D'alene copper mine site in Idaho. Studies included terrestrial soils, plants and organisms as receptors with emphasis on food web modeling and exposure level calculations. Contaminants were primarily metals with an emphasis on Copper. The focus of the ERA was to develop cleanup level goals for remediation.

IMPACT ASSESSMENT SERVICES

Environmental Impact Assessment, Global

Led the evaluation of environmental impacts for establishment of global efforts related to multiple desalination facilities. This included regional IA studies in the USA, Saudi Aribia, Norway, Malta, and other venues. Studies included detailed discharge modeling, desal water quality, transmission and power needs.

Environmental Impact Assessment, Trinidad & Tobago
Led a multi-disciplinary assessment of impacts for permitting a new port in Trinidad. This included developing ESHIA efforts, stakeholder engagement, agency interactions and development impacts ranging from air quality and climate change, biological systems, and public health and economics. The ESHIA was performed following IFC Performance Standards for the new development.

Drilling Campaign Impact Assessment, Trinidad & Tobago
Managed the international Impact Assessment for the development of a deep water oil and gas facility offshore Angola. The ESHIA was performed following IFC Performance Standards and Equator Principals guidance. This included the establishment of environmental baseline, impact analysis, all documentation, and development of regulatory support process through the license to install phase for both the facility and associated seafloor pipeline.

Drilling Campaign Impact Assessment, Angola
Developed ESIA for a new offshore platform group in the marine waters of Angola. This included impacts to marine receptors (e.g., fishes, mammals, turtles, invertebrates) and seabirds. Impacts from drilling, waste management, air quality, fisher communities (commercial and artisanal), and social impacts were included. Additional impacts related to onshore operations were included here. This resulted in the larges ESIA in Angola history.

Decommissioning Impact Assessment, Thailand
Developed ESIA focused on impacts related to decommissioning of a large oil and gas field in the Gulf of Thailand. This field consisted of 7 processing platforms and over 150 wellhead platforms. The focus of this was to conform with the Thai Decommissioning Environmental Assessment (DEA) to determine ultimate impacts from platform removal.

Permitting and Impact Analysis, California
Developed CEQA project application for decommissioning of a large coastal nuclear power plant for the project proponent. Developed all supporting CEQA studies including: Biology (marine and terrestrial); Air Quality, Water Quality; Noise (land and underwater); Traffic (marine and road); Cultural Resources; Soils and Geology; Land Use and Planning; and Restoration planning. Development of the overall project description and support for third-party EIR writers. Negations with State and Federal regulatory agencies, and development of Environmental Justice. Also developed detailed cost estimates for various Partner in Charge/Principal Ecologist

Environmental, Social, and Health Impact Assessments, Guyana
Served as the marine science lead for several ESHIA documents for offshore and onshore oil and gas operations in Guyana. This included development of marine baseline and special studies, assessment of impact levels, and development of mitigation measures. Projects included sea turtle and seabird tracking studies, fish and invertebrate population assessments, marine habitat and biodiversity studies. All studies were performed under ICF performance standards and Equator Principals level of detail. Projects included: Liza 1&2, Turbot, Stabroek, Ranger, and Pacora blocks. These blocks included ultradeep areas and associated infrastructure.

Arctic Drilling Campaign Impact Assessment, Alaska
Managed marine resources and development of components of drilling plan for resources in Alaska's Chukchi Sea. Studies included impacts of ice scour, marine noise, and drilling activities on marine mammals (cetations and pinepeds), marine fishes, and terrestrial mammals (polar bears). Marine biodiversity was established following IFC PS6 standards and the overall EIA was developed following IFC performance standards as the guiding level of analysis.

Arctic Drilling Campaign Impact Assessment, Alaska

Developed and led the marine impact assessment ESHIA team and served as the primary subject matter expert for the determination of impacts related to marine port development facilities in southwestern Alaska. Impacts evaluated included marine threatened and endangered species, fish and invertebrate communities, and marine habitats.

Underwater Noise Impacts on Marine Biodiversity, Mexico

Developed a comprehensive impact assessment methodology and supporting tools to evaluate impacts of underwater sound on marine organisms. Particular attention was placed on impacts to marine mammals. This included a detailed review of hearing physiology, physics of sound in the sea, and hearing/behavior threshold levels.

Underwater Noise Impacts on Marine Biodiversity, California

Developed an impact assessment and monitoring plan for impact hammer underwater sound from a coastal construction operation in the surf zone. Impacts from various sources and levels were used to determine safe distances and develop mitigation measures for marine mammals (cetations and pinnipeds) as well as sea birds.

Underwater Noise Impacts on Marine Biodiversity, California

Impact assessment for operational sound generated by a coastal nuclear power station. This study involved field measurements of operational sound levels along with natural background sound sources along the coastline. Data were used to develop an operational sound signature in conjunction with impacts associated with decommissioning of the facility.

Methane Hydrate Impact, Angola

Developed a detailed review of impacts associated with deep water methane hydrates. Study included search and review of existing peer-reviewed literature as well as agency and industry publications related to formation and hydrate properties, toxicology, and ecological impacts.

PORT AND HARBOR MANAGEMENT

Sediment Program Manager – Port of Long Beach, California

Managed multi-year sediment projects including maintenance dredging, new construction dredging, and Port development projects. Supervised field studies involved in dredging and risk assessment activities related to contaminated sediment issues for the Port. Projects included serving as the program manager for the West Basin, Channel Two, Pier T, and Pier S deepening and terminal development projects. Activities included regulatory interactions, sampling plan designs, field studies, and laboratory toxicity studies.

Sediment Program Manager – Port of Los Angeles, California

Managed sediment projects for the Port that included sediment sampling, testing, and long-term evaluations. Projects included maintenance dredging, and new construction dredging at various Port properties including municipal marinas, bulk loading terminals, and container terminals. Management tasks included development of detailed management plans for contaminated sediments, regulatory interactions, supervising field, and laboratory studies, and development of sediment action plans for sites at risk.

US Army Corps of Engineers, San Francisco District, Los Angeles District, and Pacific Division. Program Manager

Served as the primary contact and manager for multi-year service contracts for several U.S.ACE districts. Projects included maintenance dredging projects for over 50 sites throughout California, Oregon, and Hawaii. Managed the disposal and daily operation of the largest contained disposal facility

in California at the Galbraith Disposal Area in Oakland, California. Developed study designs, field sampling plans, and supervised field and laboratory activities related to permitting of ACOE projects.

Dredging Program Manager – Port of Oakland, California
Supervised staff in regulatory interactions, sediment quality guideline development, and permitting for routine maintenance dredging and new construction projects for the Port over multiple years. Projects included sediment studies at all Port terminals, supervision of dredging activities, and disposal operations. Served as manager for field activities for the 50-foot deepening project and Middle Harbor re-development that included collection and analysis of over 250 sediment samples.

Principal Toxicologist – Port of Portland, Oregon
Managed the ecological risk and impact assessment of the demolition of a series of salt storage tanks in the Port of Portland Terminal T4. This included site evaluations, chemical and toxicological analysis, and risk assessment to be incorporated in the impact assessment for permitting. Extensive agency interactions at the Federal, State and local level were needed prior to conclusion of the project.

Principal Toxicologist, Georgia
Worked on a large-scale lake remediation project covering 5 water bodies. Tasks included development of sampling and analysis plans, sediment collection, analysis of chemical and physical sediment properties, negotiations with key Federal and State agencies, field supervision, and data analysis/reporting.

BIODIVERSITY/ECOLOGY

Coral Reef Biodiversity Assessment – US Virgin Islands
Completed a multiple reef evaluation for coral diversity and quality and health across the US Virgin Islands. This included multiple subtidal diver surveys, detailed photo quadrats, tissue sampling, and health score calculations. Each team used in the study was assigned a separate island reef complex. The health categories included bleaching, predation, density, diversity. Additionally, tissue samples were collected to measure reproductive potential and development. Each aspect of the reef health was analyzed within the context of the reef health index. The purpose of this study was to provide USVI with an initial assessment of unimpacted reef quality.

Refinery Reef Biodiversity Evaluation, Aruba
Designed and completed a marine biodiversity assessment of reefs around the ExxonMobil refinery in Aruba. This included detailed fish, macro-invertebrate and coral surveys. Coral surveys were focused on monitoring the ecological health of the area in anticipation of a property divestment.

Marine Habitat and Biodiversity Evaluation, Turks & Caicos
Performed an assessment of marine subtidal habitats for suitability of a Giant Conch (*Lobatus gigas*) farm in the Turks & Caicos Islands. This included evaluation of subtidal seagrass community, nearby coral reefs (including coral diversity and health index), and presence of predatory species. The evaluation was used to make decisions on the size and suitability area for development of grow out pens for Conch culture.

Restoration and Biodiversity Plan, Indonesia
Developed restoration and biodiversity implementation plan for a large coastal restoration following remediation of a coastal oil and gas facility in Indonesia. The focus of the restoration was approximately 4 km of coastal mangroves. For this effort local NGO community was engage do planting and monitoring of the effort following implementation.

Wetland Biodiversity Restoration, California
Designed coastal wetland restoration effort in California to offset impacts from an offshore oil and gas decommissioning project. The focus of the restoration was to re-develop the internal coastal lagoon to facilitate recruitment of important fish resources (California halibut).

Habitat/Biodiversity Sensitivity Map, Thailand
Designed coastal habitat sensitivity map along the western shores of the Gulf of Thailand. Mapping included desktop evaluation of habitat types, species diversity, and biodiversity rankings based on species sensitivity. Following desktop analysis, field teams performed focus surveys to evaluate the rankings and to identify any additional sensitivities in the region. The result was a sensitivity map suitable for use in emergency response and planning.

Mangrove Biodiversity Restoration Plan, Mexico
Managed the coastal restoration of a large-scale mangrove forest in Eastern Mexico. A critically endangered black mangrove forest was impacted by drilling operations and required restoration under Mexican authorities. For this area approximately 2 hectares of mangrove forest was remediated, and new plantings placed in strategic areas. This helped restore water flow and provided a more robust population of the important species.

Biodiversity Restoration Plan, Thailand
Developed restoration and implementation plan for coastal nearshore communities including mangroves, dune plants, intertidal and subtidal resources. This included coral relocation efforts, mangrove plantings and artificial reef development. This work was done in conjunction with industry and university efforts in southern Thailand.

Biodiversity Evaluation, Angola
Developed and led ecological evaluations of offshore resources of Angola including sediment, biota and water quality. Developed ecological resource valuations, fisheries, project alternatives, restoration potential, and current status evaluations throughout the region.

Coral Biodiversity Restoration Plan, Brunei
Developed detailed coral restoration plan for impacts related to a subtidal blowout in Southeast Asia. Starting with detailed coral mapping of pristine and impacted reefs, specific coral species were transplanted into the impact area to develop. Long term monitoring has shown that the transplanted corals survived better than expected and the project monitoring is now ongoing with local university resources.

Biological Baseline and Biodiversity Study, Angola
Provided technical input to the study design and field effort for developing the biological baseline of a deep water exploration field. Field samples included deep water drop cameras, water and sediment quality, and benthic resources. Specific emphasis was placed on the evaluation of the presence of chemosynthetic communities. Samples were collected at depth of over 900 m at over 17 station locations in a regional background approach.

OIL AND GAS DECOMMISSIONING

Decommissioning Strategy, Australia
Developed decommissioning strategy around plastic and flexible flow lines and umbilicals around leave in place options for deep water production sites. This included detailed literature reviews, plastic degradation studies and toxicological reviews.

Decommissioning Plan, Mauritania

Developed a decommissioning plan and environmental impact assessment for marine fish populations related to the closure and dismantlement of offshore oil production and transportation facilities in the Islamic Republic of Mauritania. Developed initial environmental impacts associated with deep water decommissioning and leave-in-place options for subsea structures, lines, and associated infrastructure.

Pipeline Decommissioning Strategy Plan, Brunei

Developed a decommissioning strategy plan for offshore and onshore decommissioning of pipelines in Brunei. This included developing detailed ecological and human health risk assessments for various decommissioning options.

Platform Decommissioning Strategy Plan, Denmark

Performed an evaluation of decommissioning strategies from the environmental perspective for platform resources in the North Sea. Evaluations included understanding contaminated sediments and sub-sea structures related to decommissioning and abandonment activities planned.

Decommissioning NEBA, Thailand

Developed Net Environmental Benefit Analysis models for determining effective decommissioning options for offshore assets including central processing platforms, wellhead platforms and pipelines. Efforts included developing impact assessments for air, marine, and benthic resources.

Decommissioning Environmental Assessment, Thailand

Developed the Decommissioning Environmental Assessment (DEA) document to support the decommissioning of multiple well head, central processing, and sub-sea structures in the Gulf of Thailand. This included detailed field studies and a quantitative evaluation of decommissioning options and methods.

Decommissioning Options Analysis, UK

Managed the evaluation of decommissioning options for the Brent Sea platforms. Environmental assessment included a review of all platform assets and life cycle status, biological resources in the North Sea, and incidence of shell mound habitats underneath platforms. Additional studies included the effects of deep water trawling on biota and long-term effects in the oil fields.

Decommissioning Ecological Assessment, California

Managed the marine sciences and ecological risks associated with the disposition of residual shell mounds from the decommissioning of the 4H oil production platforms located in the Santa Barbara Channel. Led marine science investigations on the mounds, developed monitoring strategies, political strategy with CCC, CSLC, and other agencies, technical frameworks, and project designs for innovative studies to support the CEQA/NEPA process and develop the environmentally superior project alternative.

Decommissioning Ecological Impact Assessment, Alaska

Provided ecological support for determining potential effects to marine resources from decommissioning activities related to potential removal of platforms within the Cook Inlet. Studies included development of baseline ecological resources, resource mapping, and data evaluations.

Sediment Quality Objectives, California

Evaluated and developed the proposed framework for establishing sediment quality objectives for the State of California. Participated as a member of the Scientific Advisory Committee and evaluation of proposed methods for the evaluation and implementation of objectives to determine direct and indirect effects of contaminated sediments on ecological receptors.

Toxic Hot Spot Evaluation, California
Developed the California Toxic Hot Spot review and sediment quality criteria. Provided direct support as liaison to SWRCB throughout the process. Served as member of the Scientific Steering Committee.

Ecological Risk Assessment, California
In preparation for a property transfer, conducted the Ecological Risk Assessment on effects of residual PCBs and metals on the terrestrial and marine communities in Humboldt Bay, CA.

Ecological Risk Assessment, Oregon
Conducted the Ecological Risk Assessment on effects of mine tailings on a stream community at the Cornucopia mine site in eastern Oregon.

Ecological Services, California
City and County of San Francisco, Department of Public Works and the Port of San Francisco. Project Provided regulatory support, sediment study plans, field and laboratory services, and risk assessment assistance for routine maintenance dredging and development activities.

OTHER KEY PROJECTS

Deepwater Toxicity Study, California
Managed the long-term study designed to detect toxicity in sediments from sunken US Navy target ships at depths of over 2000 feet. Designed field study programs, developed innovative protocols, engineered field sampling equipment, and provided laboratory support.

Deepwater Drilling Fluid Study, California
Managed the data collection, interpretation, and statistical analysis of a long-term deep sea study of the effects of offshore discharge of drilling fluids. This study included placement of settling traps and in-situ bioassays at a depth of over 600 feet in the Santa Barbara Channel.

Wastewater Toxicity, Texas
Analyzed spatial and temporal distributions of toxicity around a municipal-industrial wastewater discharge in Texas. Designed and led field and laboratory studies to characterize waste plumes using sediment pore-water toxicity, water chemistry, and benthic diversity data.

Produced Water Toxicology, California
Analyzed the ecological effects of oil-related effluents. Designed and led both field and laboratory studies to investigate effects on reproduction, growth, and development of marine invertebrates from produced water discharges.

PUBLICATIONS

- Krause, P.R., and J. Baquiran. 2023. Subtidal intake systems for deep water desalination. Keynote address presented at the 2023 CalDesal Conference, Sacramento, CA.
- Baquiran, J. and Krause, P. (2022) Important Considerations for Pharmaceutical Development and Use in Aquaculture. Aquaculture 2022 Conference, San Diego.
- Krause, P.R., and J. Baquiran. 2019. Determining environmentally superior decommissioning options for hard and flexible pipelines. Society of Petroleum Engineers, SPE Journal. 2019.
- Jagerroos, S. and P.R. Krause. 2016. Rigs-to Reefs; Impact or enhancement on marine biodiversity. Journal of Ecosystem and Ecography. 16-438.
- Krause, P.R., M. Hartley, and W. Gala. 2015. Mitigation and restoration to enhance biodiversity. Presented at the International Association of Impact Assessment conference, Florence, Italy. 2015.

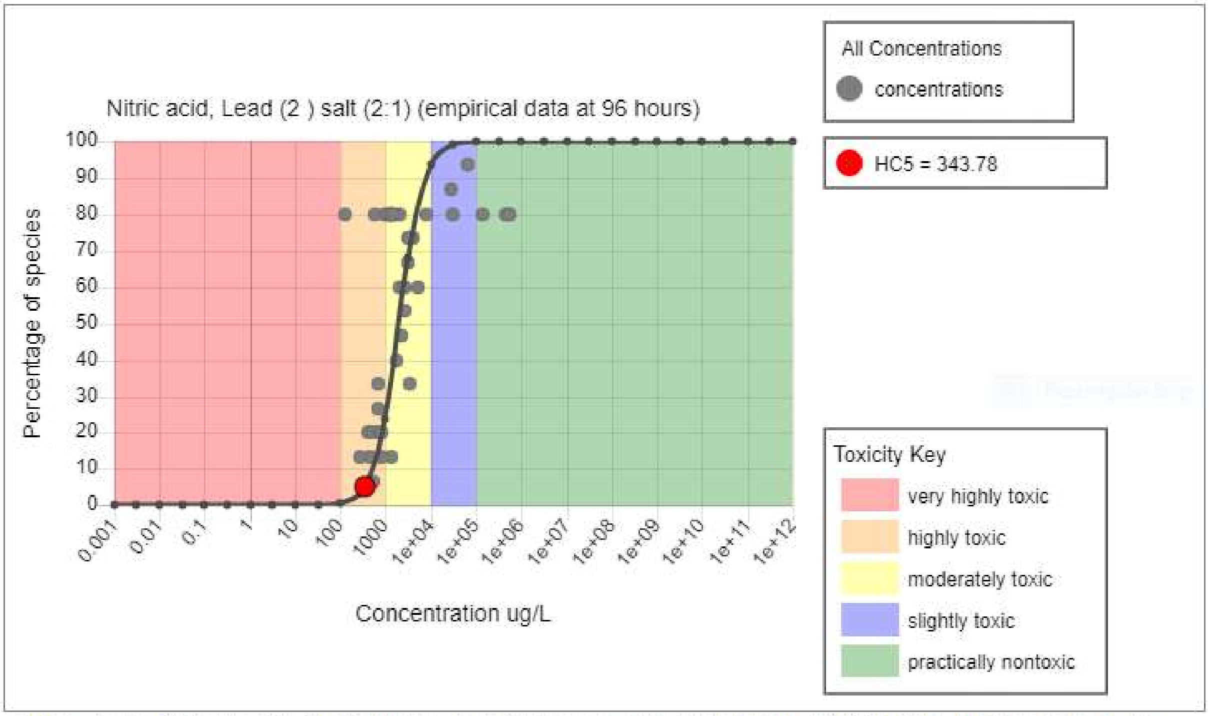
- Krause, P.R. 2014. Ecological value of leave-in-place and reefing options in temperate environments: Case studies from decommissioning projects in California, U.S.A. Society of Petroleum Engineers, SPE Journal. 2014
- Krause, P.R. J. Holder, and E. Buchak. 2013. Environmental baseline studies in the IA: Form and Function. Presented at the International Association of Impact Assessment conference, Calgary, Alberta, Canada. 2013
- Krause, P.R., R. Hill, and W.R. Gala. 2012. The Ecological resources on shell mound habitats surrounding platform decommissioning sites in the Santa Barbara Channel, California, U.S.A. Society of Petroleum Engineers, SPE Journal. 2012
- Krause, P.R. 2010. A new artificial reef in Santa Barbara, California: An example of environmental enhancement from oil field decommissioning activities. Presented at the Ecological Society of America, 2010 Annual Conference, Pittsburgh, PA.
- Krause, P.R., R. W. Hill, W.R. Gala, and S. Larew. 2010. Determining the ecological value of fish resources at platform decommissioning sites using ROV and trapping techniques in the Santa Barbara Channel, U.S.A. Society of Petroleum Engineers, SPE Journal 2010.
- Krause, P.R. 2002. Ecological toxicology of produced water. Proceeding, 2002 Information Transfer Meeting, US Department of the Interior, Minerals Management Service, Gulf Coast Region.
- Raimondi, P.T., A.M. Barnett, and P.R. Krause. 1997. The effects of drilling muds on marine invertebrate larvae and adults. Env. Tox. and Chem.16(6):1218-1228.
- Krause, P.R. 1995. Spatial and temporal variability in receiving water toxicity near an oil effluent discharge site. Arch. Env. Contam. Toxicol. 29:523-529.
- Krause, P.R. 1994. Effects of produced water on gametogenesis and gamete performance in the purple sea urchin (*Strongylocentrotus purpuratus*). Env. Tox. and Chem. 13(7): 1153-1161.

APPENDIX B

Dissolved Lead (Pb^{2+}) Species Sensitivity Distribution and HC_5 calculation page from NOAA CAFE Database (https://response.restoration.noaa.gov/cafe). Accessed May, 9, 2024.

CAFE Effects Graph

portrait view | landscape view | print | return



Source EcoTox (39) Ecetoc (5) **Species Groups** Coral (0) Crustacean (10) Fish (31) Mollusk (0) Other (3) **LifeStages** Embryo (1) Larva (0) Juvenile (12) Adult (6) Unknown (25) **EndPoints** LC50 (39) EC50 (3) LOEC (1) NOEC (1) **Species Distribution** Frigid (0) Pandemic (0) SubTropical (0) Tropical (0) Temperate (40) Unknown (4) **WaterTypes** Salt Water (0) Fresh Water (44) Estuarine (0) Not Reported (0) **Applicability** High (6) Moderate (4) Low (34)

Species Names

Amphipod, Crangonyx pseudogracilis Aquatic Sowbug, Asellus aquaticus Atlantic Salmon, Salmo salar Brook Trout, Salvelinus fontinalis Common Carp, Cyprinus carpio Copepod, Thermocyclops hyalinus Crayfish, Austropotamobius pallipes Fathead Minnow, Pimephales promelas Green Algae, Chlorella vulgaris Mayfly, Drunella grandis Ostracod, Diacypris compacta Rainbow Trout, Oncorhynchus mykiss Water Flea, Ceriodaphnia reticulata Water Flea, Daphnia magna